THE
PHILOSOPHICAL MAGAZINE,
OR
ANNALS
OF
CHEMISTRY, MATHEMATICS, ASTRONOMY, NATURAL HISTORY, AND GENERAL SCIENCE.

BY
RICHARD TAYLOR, F.S.A. L.S. G.S. M. Astr. S. &c.
AND
RICHARD PHILLIPS, F.R.S. L. & E. F.L.S. &c.

"Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." Just. Lips. *Monit. Polit.* lib. i. cap. 1.

VOL. VI.

NEW AND UNITED SERIES OF THE PHILOSOPHICAL MAGAZINE AND ANNALS OF PHILOSOPHY.

JULY—DECEMBER, 1829.

LONDON:

PRINTED BY RICHARD TAYLOR, RED LION COURT, FLEET STREET:
Printer to the University of London.

AND SOLD BY LONGMAN, REES, ORME, BROWN, AND GREEN; CADELL; BALDWIN AND CRADOCK; SHERWOOD, GILBERT, AND PIPER; SIMPKIN AND MARSHALL; UNDERWOOD; W. PHILLIPS; HARDING; HIGHLEY, LONDON: — AND BY ADAM BLACK, EDINBURGH; SMITH AND SON, GLASGOW; AND HODGES AND M'ARTHUR, DUBLIN.

ALERE FLAMMAM

TABLE OF CONTENTS.

NUMBER XXXI.—JULY.

NUMBER XXXII.—AUGUST.

Mr.

NUMBER

Page

NUMBER XXXIII.—SEPTEMBER.

NUMBER XXXIV.—OCTOBER.

Mr.

NUMBER XXXV.—NOVEMBER.

M. Ber-

NUMBER XXXVI.—DECEMBER.

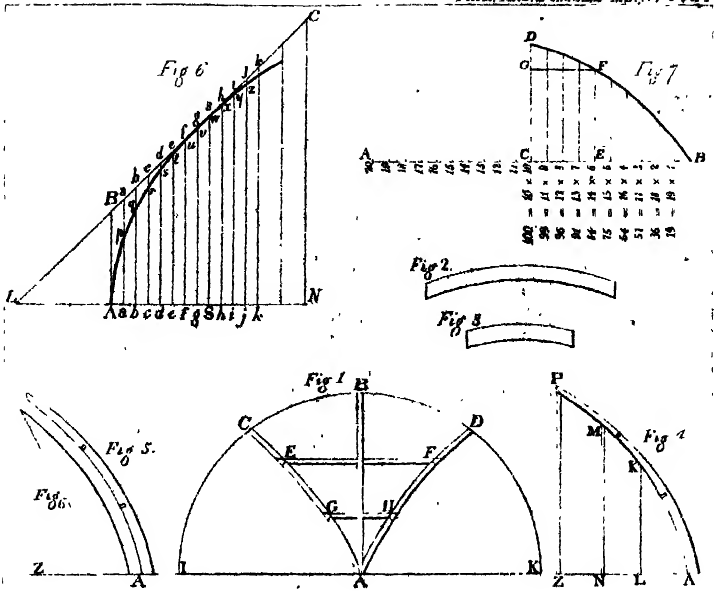
PLATES.

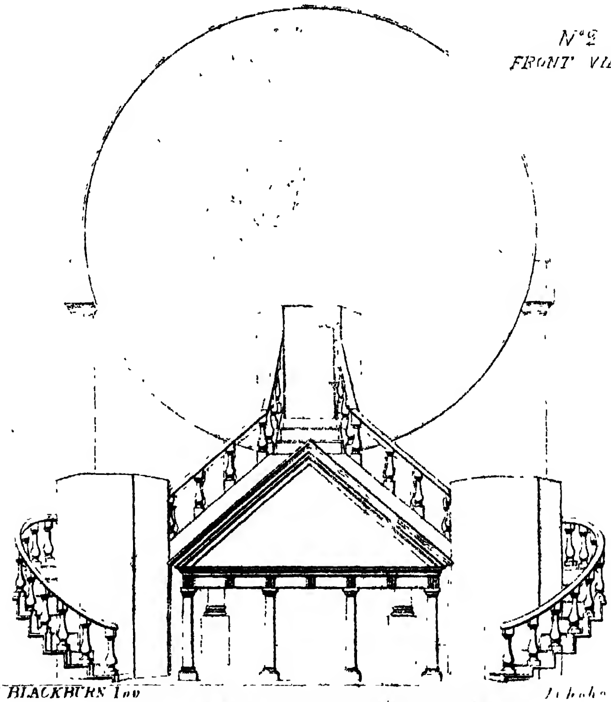
I. Plate illustrative of the Rev. J. Blackburn's Parabolic Sounding Board.

II. Plate illustrative of Mr. De la Beche's Paper on the Excavation of Valleys.

Errata.

P. 76, line 19, *for* hyposulphate *read* hyposulphite.
——— 26, *for* oxyhydrous *read* anhydrous.
——— 30, *for* lime *read* calcium.
——— 31, *for* hyposulphate *read* hyposulphite.
——— 32, *for* sulphate *read* sulphite.
——— 34, *for* hyposulphates and sulphates *read* hyposulphites and sulphites.
P. 215, line 6, *for* connected *read* converted.
——— 25, *for* fusus *read* fucus.
In the Plate accompanying Mr. De la Beche's Paper on the Excavation of Valleys, the gravel strewed on the sides, and which occurs in the bottom of the valley, fig. 1, (section of Charmouth Valley) i represented too thick.
P. 254, line 17, *for* low pressure *read* low temperature.





Revd J BLACKBURN Inv

SOUNDING BOARD IN ATTERCLIFFE CHURCH SHEFFIELD

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

JULY 1829.

I. *The Bakerian Lecture.—On a Method of rendering Platina malleable. By* WILLIAM HYDE WOLLASTON, *M.D. F.R.S. &c.**

AS, from long experience, I probably am better acquainted with the treatment of platina, so as to render it perfectly malleable, than any other member of this Society, I will endeavour to describe, as briefly as is consistent with perspicuity, the processes which I put in practice for this purpose, during a series of years, without seeing any occasion to wish for further improvement.

The usual means of giving chemical purity to this metal, by solution in aqua regia and precipitation with sal ammoniac, are known to every chemist; but I doubt whether sufficient care is usually taken to avoid dissolving the iridium contained in the ore, by due dilution of the solvent. In an account which I gave in the Philosophical Transactions for 1804, of a new metal, rhodium, contained in crude platina, I have mentioned this precaution, but omitted to state to what degree the acids should be diluted. I now therefore recommend, that to every measure of the strongest muriatic acid employed, there be added an equal measure of water; and moreover, that the nitric acid used be what is called "single aquafortis;" as well for the sake of obtaining a purer result, as of œconomy in the purchase of nitric acid.

With regard to the proportions in which the acids are to be used, I may say, in round numbers, that muriatic acid, equivalent to 150 marble, together with nitric acid equivalent

* From the Philosophical Transactions for 1829. Part I.

to 40 marble, will take 100 of crude platina; but in order to avoid waste of acid, and also to render the solution purer, there should be in the menstruum a redundance of 20 per cent at least of the ore. The acids should be allowed to digest three or four days, with a heat which ought gradually to be raised. The solution, being then poured off, should be suffered to stand until a quantity of fine pulverulent ore of iridium, suspended in the liquid, has completely subsided; and should then be mixed with 41 parts of sal ammoniac, dissolved in about five times their weight of water. The first precipitate, which will thus be obtained, will weigh about 165 parts, and will yield about 66 parts of pure platina.

As the mother-liquor will still contain about 11 parts of platina, these, with some of the other metals yet held in solution, are to be recovered, by precipitation from the liquor with clean bars of iron, and the precipitate is to be redissolved in a proportionate quantity of aqua regia, similar in its composition to that above directed to be used: but in this case, before adding sal ammoniac, about 1 part by measure of strong muriatic acid should be mixed with 32 parts by measure of the nitro-muriatic solution, to prevent any precipitation of palladium or lead along with the ammonio-muriate of platina.

The yellow precipitate must be well washed, in order to free it from the various impurities which are known to be contained in the complicated ore in question; and must ultimately be well pressed, in order to remove the last remnant of the washings. It is next to be heated, with the utmost caution, in a black-lead pot, with so low a heat as just to expel the whole of the sal ammoniac, and to occasion the particles of platina to cohere as little as possible; for on this depends the ultimate ductility of the product.

The gray product of platina, when turned out of the crucible, if prepared with due caution, will be found lightly coherent, and must then be rubbed between the hands of the operator, in order to procure by the gentlest means, as much as can possibly be so obtained, of metallic powder, so fine as to pass through a fine lawn sieve. The coarser parts are then to be ground in a wooden bowl with a wooden pestle, but on no account with any harder material, capable of burnishing the particles of platina*; since every degree of burnishing will prevent

* The following experiment will prove the necessity of attending to this precaution:—If a wire of platina be divided with a sharp tool in a slanting direction, and, being then heated to redness, be struck upon an anvil with a hammer, so as to force into contact the two newly-divided surfaces, they will become firmly welded together; but if the surfaces have previously been

prevent the particles from cohering in the further stages of the process. Since the whole will require to be well washed in clean water, the operator, in the later stages of grinding, will find his work much facilitated by the addition of water, in order to remove the finer portions, as soon as they are sufficiently reduced to be suspended in it.

Those who would view this subject scientifically should here consider, that as platina cannot be fused by the utmost heat of our furnaces, and consequently cannot be freed like other metals, from its impurities, during igneous fusion, by fluxes, nor be rendered homogeneous by liquefaction, the mechanical diffusion through water should here be made to answer, as far as may be, the purposes of melting; in allowing earthy matters to come to the surface by their superior lightness, and in making the solvent powers of water effect, as far as possible, the purifying powers of borax and other fluxes in removing soluble oxides.

By repeated washing, shaking, and decanting, the finer parts of the gray powder of platina may be obtained as pure* as other metals are rendered by the various processes of ordinary metallurgy; and if now poured over, and allowed to subside in a clean basin, a uniform mud or pulp will be obtained, ready for the further process of casting.

The mould which I have used for casting, is a brass barrel, 6¾ inches long, turned rather taper within, with a view to facilitate the extraction of the ingot to be formed, being 1·12 inches in diameter at top, and 1·23 inches at a quarter of an inch from the bottom, and plugged at its larger extremity with a stopper of steel, that enters the barrel to the depth of a quarter of an inch. The inside of the mould being now well greased with a little lard, and the stopper being fitted tight into the barrel by surrounding it with blotting-paper, (for the paper facilitates the extraction of the stopper, and allows the escape of water during compression,) the barrel is to be set upright in a jug of water, and is itself to be filled with that fluid. It is next to be filled quite full with the mud of platina; which, subsiding to the bottom of the water, is sure to fill the

been burnished with any hard substance, the welding will be effected, if at all, with very great difficulty.

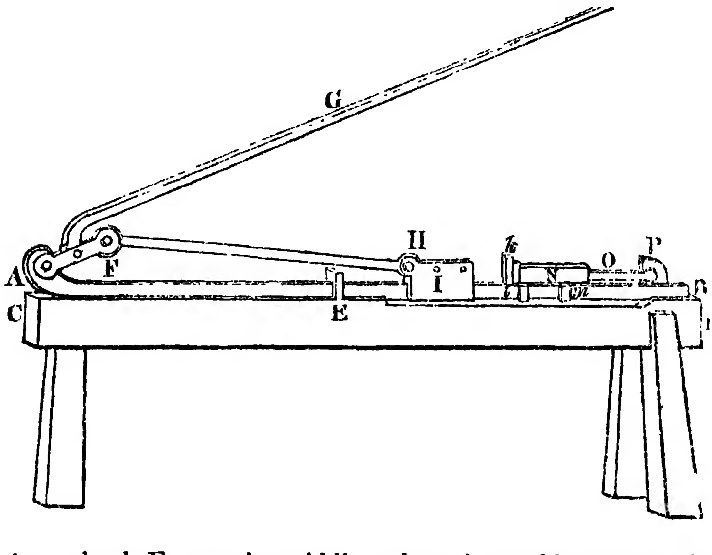
When the powder of platina has been over-heated in decomposing the ammonio-muriate, or has been burnished in the grinding, I have in vain endeavoured to give it a welding surface, by steeping it in a solution of sal ammoniac in nitric acid.

* Sulphuric acid, digested upon the gray powder of platina, thus purified, extracted less than 1-1000dth part of iron.

 barrel

barrel without cavities, and with uniformity,—a uniformity to be rendered perfect by subsequent pressure. In order, however, to guard effectually against cavities, the barrel may be weighed after filling it, and the actual weight of its contents being thus ascertained, may be compared with that weight of platina and water which it is known by estimate that the barrel ought to contain *. A circular piece of soft paper first, and then of woollen cloth, being laid upon the surface, allow the water to pass, during partial compression by the force of the hand with a wooden plug. A circular plate of copper is then placed upon the top, and thus sufficient consistency is given to the contents to allow of the barrel being laid horizontally in a forcible press.

The press which I have generally used for this purpose, consists of a flat iron bar AB, set edgeways, and screwed down



by a hook E, near its middle, where it would otherwise be

* From the mean weight of the ingots obtained in previous operations, it is known that the barrel described in the text ought to contain 16 ounces troy of dry platina powder. The weight of the contents of the barrel $= 16$ ounces $\times \frac{\text{sp. grav. of platina} - 1}{\text{sp. grav. of platina}} +$ the weight of a cubic inch of water $\times$ capacity of the barrel in cubic inches $= 16$ ounces $\times \frac{20{\cdot}25}{21{\cdot}25} + {\cdot}526$ ounces $\times 7{\cdot}05 = 18{\cdot}9575$ ounces troy. Should the contents of the barrel weigh materially less than this estimated weight, there must be a want of uniformity in the disposition of the powder within the barrel.

liable

liable to bend, to a strong wooden bench CD. The bar is connected by a pivot at its extremity A, with the lever AFG. An iron rod FH, which turns at its two extremities upon the pivots F and H, proceeds from the lever at F, and, as the lever descends, propells forward the carriage I, which slides along the bar. A stopper or block being placed in the vacant space I*k*, the carriage communicates motion to the cradle *klm*, which is also made to slide along the bar, and carries the barrel N, which lies upon the cradle, straight against the piston O, which rests by its end against P, a projection in the further extremity of the bar.

The weight, which in this machine, when the angle of the lever's elevation is small, will keep the power, applied vertically at the extremity of the lever, *in equilibrio* = that power × $\frac{AG \times FH}{AF[AF+FH]}$ × cotan. of the angle of the lever's elevation; which expression, in the case of the press actually used, becomes, power × 5 . cotan. of the angle of the lever's elevation. This expression, at an elevation of 5°, becomes nearly 60 × power, and at an elevation of 1°, becomes nearly 300 × power; and when the lever becomes horizontal, the multiplier of the power becomes *quasi* infinite. This explanation will be sufficient to show the mechanical advantage with which, by means of this press, the weight of the operator, acting on the end of the lever, will be made to bear against the area of the section of the barrel, a circle little more than an inch in diameter.

After compression, which is to be carried to the utmost limit possible, the stopper at the extremity being taken out, the cake of platina will easily be removed, owing to the conical form of the barrel; and being now so hard and firm that it may be handled without danger of breaking, it is to be placed upon a charcoal fire, and there heated to redness, in order to drive off moisture, burn off grease, and give to it a firmer degree of cohesion.

The cake is next to be heated in a wind-furnace; and for this purpose is to be raised upon an earthen stand about 2½ inches above the grate of the furnace, the stand being strown over with a layer of clean quartzose sand, on which the cake is to be placed, standing upright on one of its ends. It is then to be covered with an inverted cylindrical pot, of the most refractory crucible ware, resting at its open end upon the layer of sand; and care is to be taken that the sides of the pot do not touch the cake.

To prevent the blistering of the platina by heat, which is the usual defect of this metal in its manufactured state, it is essential

essential to expose the cake to the most intense heat that a wind-furnace can be made to receive, more intense than the platina can well be required to bear under any subsequent treatment; so that all impurities may be totally driven off, which any lower temperature might otherwise render volatile. The furnace is to be fed with Staffordshire coke, and the action of the fire is to be continued for about twenty minutes from the time of lighting it, a breathing heat being maintained during the last four or five minutes.

The cake is now to be removed from the furnace, and being placed upright upon an anvil, is to be struck, while hot, on the top, with a heavy hammer, so as at one heating effectually to close the metal. If in this process of forging, the cylinder should become bent, it should on no account be hammered on the side, by which treatment it would be cracked irremediably; but must be straightened by blows upon the extremities, dexterously directed, so as to reduce to a straight line the parts which project.

The work of the operator is now so far complete, that the ingot of platina may be reduced, by the processes of heating and forging, like that of any other metal, to any form that may be required. After forging, the ingot is to be cleaned from the ferruginous scales which its surface is apt to contract in the fire, by smearing over its surface with a moistened mixture of equal parts by measure of crystallized borax and common salt of tartar, which, when in fusion, is a ready solvent of such impurities*, and then exposing it, upon a platina tray, under an inverted pot, to the heat of a wind-furnace. The ingot on being taken out of the furnace, is immediately to be plunged into dilute sulphuric acid, which in the course of a few hours will entirely dissolve the flux adhering to the surface. The ingot may then be flattened into leaf, drawn into wire, or submitted to any of the processes of which the most ductile metals are capable.

The perfection of the methods above described, for giving

* The chemist will find this flux very serviceable for removing from his crucible or other vessels of platina those ferruginous scales with which, after long use, and particularly after being strongly heated in a coal or coke fire, they become incrusted. In the analysis of earthy minerals, I have been in the habit of using a similar flux, composed of 2 parts by weight of crystallized carbonate of soda, and 1 of crystallized borax, well ground together. It has the advantage of not acting, like caustic alkali, upon the platina crucible, and is a powerful solvent of jargon and many other minerals, which yield with difficulty to other fluxes. If the mineral to be operated on requires oxidation, in order to decompose it, a little nitre or nitrate of soda may be added.

to

to platina complete malleability, will best be estimated by comparing the metal thus obtained, in respect of its specific gravity, with platina which has undergone complete fusion; and by comparing it, in respect of its tenacity, with other metals possessing that quality in the greatest perfection.

The specific gravity of platina, drawn into fine wire, from a button which had been completely fused by the late Dr. E. D. Clarke with an oxy-hydrogen blowpipe, I found to be 21·16. The aggregate specific gravity of the cake of metallic mud, when first introduced into the barrel, exclusively of moisture, is about 4·3; when taken from the press, is about 10. That of the cake fully contracted, on being taken out of the wind-furnace before forging, is from 17 to 17·7. The mean specific gravity of the platina, after forging, is about 21·25, although that of some rods, after being drawn, is 21·4: but that of fine platina wire, determined by comparing the weight of a given length of it with the weight of an equal length of gold wire drawn through the same hole, I find to be 21·5, which is the maximum specific gravity that we can well expect to be given to platina.

The mean tenacity, determined by the weights required to break them, of two fine platina wires, the one of $\frac{1}{3000}$, the other of $\frac{1}{3850}$ of an inch in diameter, reduced to the standard of a wire $\frac{1}{10}$th of an inch in diameter, I found to be 409 pounds; and the mean tenacity of 11 wires, beginning with $\frac{1}{4300}$ and ending with $\frac{1}{23000}$ of an inch, reduced to the former standard, I found to be 589 pounds; the maximum of these 11 cases being 645 pounds, and the minimum 480 pounds. The coarsest and the finest wire which I tried, present exceptions, since a wire of $\frac{1}{1300}$ of an inch gave 290 pounds, and a wire of $\frac{1}{30 \cdot 000}$ of an inch, 190 pounds. If we take 590 pounds, as determined by the 11 consecutive trials, to be the measure of the tenacity of the platina prepared by the processes above described, and consider that the tenacity of gold wire, reduced to the same standard, is about 500, and that of iron-wire, 600, we shall have full reason to be satisfied with the processes, detailed in the present paper, by which platina has been rendered malleable.

To this paper I beg to subjoin an account of some processes relating to two of the metals which are found in the ore of platina.

To obtain malleable palladium, the residuum obtained from burning the prussiate of that metal is to be combined with sulphur, and each cake of the sulphuret, after being fused, is

to

to be finally purified by cupellation, in an open crucible, with borax and a little nitre. The sulphuret is then to be roasted, at a low red heat, on a flat brick, and pressed, when reduced to a pasty consistence, into a square or oblong and perfectly flat cake. It is again to be roasted very patiently, at a low red heat, until it becomes spongy on the surface. During this process, sulphur flies off in the state of sulphurous acid, especially at those moments when the heat is allowed occasionally to subside. The ingot is then to be cooled; and when quite cold, is to be tapped with a light hammer, in order to condense and beat down the spongy excrescences on its surface. The alternate roastings and tappings (or gentle hammerings) require the utmost patience and perseverance, before the cake can be brought to bear hard blows: but it may, by these means, at length be made so flat and square, as to bear being passed through the flatting-mill, and so laminated to any required degree of thinness.

Thus prepared, it is always brittle, while hot; possibly, from its still containing a small remnant of sulphur. I have also fused some palladium *per se*, without using sulphur; but I have always found it, when treated in this way, so hard and difficult to manage, that I greatly prefer the former process.

To obtain the oxide of osmium in a pure, solid, and crystallized state, I grind together, and introduce, when ground, into a cold crucible, 3 parts by weight of the pulverulent ore of iridium, and 1 part of nitre. The crucible is to be heated to a good red in an open fire, until the ingredients are reduced to a pasty state; when osmic fumes will be found to arise from it. The soluble parts of the mixture are then to be dissolved in the smallest quantity of water necessary for the purpose, and the liquor, thus obtained, is to be mixed, in a retort, with so much sulphuric acid, diluted with its weight of water, as is equivalent to the potash contained in the nitre employed; but no inconvenience will result from using an excess of sulphuric acid. By distilling rapidly into a clean receiver, for so long a time as the osmic fumes continue to come over, the oxide will be collected in the form of a white crust on the sides of the receiver; and there melting, it will run down in drops beneath the watery solution, forming a fluid flattened globule at the bottom. When the receiver has become quite cold, the oxide will become solid and crystallize. One such operation has yielded 30 grains of the crystallized oxide, besides a strong aqueous solution of it.

II. *An*

II. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. Children, *F.R.S. L. & E. F.L.S. &c.*

[Continued from vol. v. p. 370.]

Genus 53. MANIA, *Ochs., Treitsch.*

Mormo, Ochs. Lemures, Hübn.

Legs, gressorial; *second* and *third pair* with the *tibiæ* armed with long, stout spines, terminated by a very fine point.
Wings triangular, margins crenate.
Antennæ filiform, pectinated; pectinations extremely short.
Body rather stout; *thorax* densely pilose; *back* with a separate tuft of hair on each segment, except the last, forming a crest down the middle; *abdomen* terminated by a tuft of hairs.
Larva naked, with a small head; *body* tapering towards the hinder part; the last segment tuberculated.
Obs. *Mormo* being a term already employed in ornithology, M. Treitschke has rejected it, and adopted that of *Mania* in its stead.

Species.	Icon.
1. Man. *Maura*, Linn....	Ernst, VIII. Pl. CCCXIX. f.561.
2. — *Typica*, Linn.*...	Ernst, VII. Pl. CCLXXXI. f.461.

Genus 54. HADENA, *Schrank.*

Wings deflexed; *body* with tufts of hair on the back, forming a longitudinal crest; (as in the preceding genus;) posteriorly gibbous.
Larvæ various: *Pupa* subterranean. Treitschke has subdivided this genus into four families, founded (except the second) on certain markings on the anterior wings, not, however, sufficiently definite or constant to afford good lines

* Nænia, Steph.
" *Palpi* rather long, porrect, ascending, triarticulate, the two basal joints clothed with elongate capitate scales, terminating in an acute point anteriorly, at the apex of the second joint, apical joint slender, elongate, exposed, covered with abbreviated scales; basal joint of equal length with the terminal, and slightly bent, the second nearly as long again, more slender than the first, a little attenuated at the apex; terminal linear, very slender, slightly acuminated: *maxillæ* longer than the antennæ. *Antennæ* short, slender in the females, ciliated internally in

lines of demarcation between the respective groups. They are briefly as follows:

FAM. A. With fine lines and transverse bands of a light colour on the anterior wings.

—— B. The males with strongly pectinated antennæ.

—— C. The anterior wings with an indented transverse band near the outer margin, and irregular oblong or reniform spots between the indented band and the base of the wing.

—— D. The anterior wings with light-coloured transverse fasciæ, and a conical spot, extending from the base of the wings nearly to the second cross band.

FAM. A. Species.	Icon.
1. H. *Saponariæ*, Hübn.	Ernst, VII. Pl. CCLXXXI. f. 462.
2. — *Perplexa*, Hübn.	Ernst, VII. Pl. CCXC. f. 488. c. d.
3. — *Capsincola*, Hübn.	Ernst, VII. Pl. CCLXXX. f. 460.
4. — *Cucubali*, Hübn.	Ernst, VII. Pl. CCLXXXI. f. 463.
FAM. B.	
5. H. *Popularis*, Fab....	Ernst, V. Pl. CLXXXVII. f. 243. 244.
6. — *Leucophæa*, Hübn.	Ernst, V. Pl. CLXXXVIII. f. 245. c—h.
FAM. C.	
7. H. *Glauca*, Hübn....	Hübn. Noct. Tab. 87. f. 410. (fœm.)
8. — *Proxima*, Hübn.	Hübn. Noct. Tab. 87. f. 409. (fœm.)
9. — *Marmorosa*, Bork.	Ernst, VI. Pl. CCXXXVII. f. 348.
10. — *Dentina*, Hübn...	Ernst, VI. Pl. CCXLII. f. 356.
11. — *Peregrina*, Treitsch.*	
FAM. D.	
12. H. *Amica*, Treitsch.†	

in the males: *head* small, with a crest between the antennæ: *eyes* rather prominent, naked: *thorax* stout, with an anterior and posterior crest: *abdomen* slightly depressed, with a carina in the male: *wings* incumbent, faintly denticulate: *legs* short, rather stout. *Larva* naked, with the anal segment a little elevated: *pupa* folliculated, with a single spine at the apex."—*Steph. Illust. Brit. Ent. Haustell.* II. 165.

Stephens complains of the unnatural union of the Noctuæ *Maura* and *Typica*, Linn. effected by Ochsenheimer and Treitschke, "than which," he says, "nothing can be more unnatural, their only resemblance consisting in the dinginess of their colours."—"Nænia may be readily known by the peculiar bifid appearance of the apex of the palpi, arising from the elongation of the scales,—combined with the highly crested thorax, dingy, reticulated, and subcrenated wings."—*Steph. l. c.*

* Had. alis anticis argillaceis, maculâ conicâ obscuriori, strigâ posticâ dentatâ albidâ, maculis sagittiformibus brunneis; posticis albis, fusco venosis.—*Treitschke.*

† Had. alis anticis fusco rubroque variis, maculâ anteriori oblongâ, reniformique albidis, fasciâ posticâ violaceâ.

13. *Sa-*

Species.	Icon.
13. H. *Satura*, Hübn.....	Ernst, VII. Pl. CCLXXXVI. f. 475. b. c.
14. — *Adusta*, Hübn. ...	Ernst, VII. Pl. CCLXXXVI. f. 476. c.
15. — *Thalassina*, Borkh.	Ernst, VII. Pl. CCLXXXVI. f. 474. a. b.
16. — *Gemina*, Hübn...	Ernst, VII. Pl. CCLXXXV. f. 471.
17. — *Genistæ*, Hubn...	Ernst, VII. Pl. CCLXXXV. f. 473.
18. — *Contigua*, Fab. ...	Ernst, VII. Pl. CCLXXXV. f. 472.
19. — *Æruginea*, Hübn.	Ernst, VII. Pl. CCLXXXIX. f. 482.
20. — *Convergens*, Fab.	Hübn. Noct. Tab. 18. f. 84. (mas.)
21. — *Distans*, Hübn...	Hübn. Noct. Tab. 112. f. 522. (mas.) 523. (fœm.)
22. — *Protea*, Hübn. ...	Hübn. Noct. Tab. 87. f. 406. (mas.)

Genus 55. ERIOPUS*, *Treitsch.*

Legs, anterior pair porrected when at rest, in the males furnished with long woolly hairs, as far as the penultimate joint of the tarsus; in the females naked.

Antennæ slightly pectinated on the inner side, in the males, rather pubescent beneath; simple in the females.

Wings, anterior deflexed, angular.

Larva solitary, feeds on the *Pteris aquilina* (Common Fern) and always keeps underneath the leaves; *head* light-brown or fulvous; *body* delicate green, with a white stripe, margined with brown on the sides and stigmata, and a transverse line and a crescent of the same colours on each segment, the points of the crescent being directed towards the anus. *Duponch. Lep. de France*, vi. 326.

Pupa subterranean. *Id. l. c.*

Esper had named the species on which Treitschke has formed this genus *Lagopus*; but as that term is already adopted in Ornithology, the latter has changed the appellation to Eriopus.

Species.	Icon.
1. Eri. *Pteridis*, Hübn.	Hübn. Noct. Tab. 13. f. 65. (fœm.)
	——— Larv. Lepid. IV. Noct. II. Genuin. E. e. fig. a. b.
	Duponch. VI. pl. 93. fig. 1. (mas.) fig. 2. (fœm.)

The only species of the genus.

* Εριον lana, πους pes—*woolly foot.*

Genus 56. PHLOGOPHORA *, *Treitsch.*

Antennæ long, setaceous, slightly pectinated on the inner side.
Wings indented; anterior rounded or angular, generally variegated with brilliant colours.
Body, thorax crested.
Larva rather long and slender, with a small tubercle on the anal segment; delicately marked with longitudinal and transverse lines; feeds chiefly on low plants.
Pupa folliculated; *metamorphosis* subterranean.

FAM. A.—Wings involuted when at rest, crenate; the anterior marked with brilliant colours.
FAM. B.—Wings rounded, less involuted, subdeflexed; only the cilia crenate.

FAM. A. Species.	Icon.
1. Phl. *Adulatrix*, Hübn.	Hübn. Noct. Tab. 111. fig. 517. (fœm.) Tab. 142. fig. 649. 650. (mas.)
2. — *Scita*, Hübn.......	Hübn. Noct. Tab. 14. fig. 68. (fœm.) Tab. 101. fig. 475. (mas.)
3. — *Meticulosa*, Linn.	Ernst, VII. Pl. CCXC. f. 487.
FAM. B.	
4. Phl. *Lucipara*, Linn...	Ernst, VII. Pl. CCXCII. f. 491.
5. — *Fovea*, Treitsch.†	
6. — *Empyrea*, Hübn.	Ernst, VII. Pl. CCLXVII. f. 426.

Genus 57. MISELIA ‡, *Treitsch.* (*Curtis.*)

MISELIÆ, Hübn.

Antennæ inserted close to the eyes, on the crown of the head, long, setaceous, robust in the males, sometimes produced on the inside; covered with scales above, pubescent beneath, basal joint cup-shaped, the scales extending far beyond the edge.
Maxillæ spiral, setaceous, not longer than the antennæ, furnished with tentacula at the apex.
Labial palpi short, porrected somewhat obliquely, thickly clothed with scales excepting the terminal joint, which is almost naked; 3-jointed, basal joint rather robust, 2nd long and not so thick, 3rd elongate obovate.

* Φλοξ *flamma*, φερω *fero*.
† Phl. alis anticis purpurascentibus lucidis, fasciâ nigrâ, stigmate postico maculâque marginis interioris flavis: posticis cinereis, foveâ pellucidâ in mare.—*Ochs. Treitsch.* V *pars* I. *p.* 380.
‡ Μισω *odio*, Ἥλιος *Sol*.

Head

Head tufted on the crown: *eyes* rather small and oval.

Body, *thorax* quadrate, thickly clothed with scales: *abdomen* large, robust, angulated, tufted on the back near the base, ovate conic in the females.

Wings slightly deflexed; *superior* large, the posterior margin and cilia crenate; inferior rather small.

Legs strong, anterior the shortest: *femora* thickly ciliated: *tibiæ*, anterior thickly clothed with scales, concealing the internal spine, middle and posterior spurred, the latter having a pair above the apex, one being very short: *tarsi* 5-jointed, basal joint the longest, as long as the tibia in the anterior pair: *claws* distinct, bifid: *pulvilli* small.

Larva, head and pectoral segments depressed, penultimate gibbous or tuberculated *.

Species.	Icon.
1. Mis. *Conspersa*, Hübn.	Ernst, VI. Pl. CCXXX. f. 332. c. g.
2. — *Compta*, Hübn....	Ernst, VI. Pl. CCXXX. f. 332. a. b.
3. — *Albimacula*, Borkh.	Ernst, VI. Pl. CCXXX. f. 331.
4. — *Gemmea*, Treitsch.†	
5. — *Culta*, Fab.........	Ernst, VI. Pl. CCXXIX. f. 329.
6. — *Serpentina*, Treitsch.‡	
7. — *Oleagina*, Fab.§...	Ernst, V. Pl. CLXXXVI. f. 241.
8. — *Orbiculosa*, Esper.	Esper. Schm. III. Th. Tab. 93. f. 8.
9. — *Oxyacanthæ*, Linn.	Ernst, VI. Pl. CCXXIX. f. 328.
10. — *Bimaculosa*, Linn.	Ernst, VI. Pl. CCXXIX. f. 327. Curtis, Brit. Ent. IV. Pl. 177. Imago et Larva.
11. — *Aprilina*, Linn....	Ernst, VI. Pl. CCXXVIII. f. 326.

Genus 58. POLIA, *Treitsch.* (*Curtis.*)

Poliæ, Hübner.

Antennæ inserted close to the eyes on the crown of the head, setaceous, rather stouter in the males, composed of numerous

* Characters from Curtis, *Brit. Ent.* IV. 177.

† Mis. alis anticis fuscis flavo alboque variis, maculis ordinariis albis, lineisque transversis arcuatis atris; posticis cinereis, lunulâ mediâ fasciâque terminali fuscis.—*Ochs. Treitsch.* V. *pars* I. 393.

‡ Mis. alis anticis viridescenti fuscis, nigro undatis, maculâ reniformi albâ; posticis maris niveis nigrocinctis, fœminæ cinereo adspersis.—*Ochs. Treitsch.* V. *pars* I. 399.

§ Curtis rejects this species, as incompatible with the genus, on account of its strongly pectinated antennæ. Fabricius classes it with the Bombyces.

merous transverse joints, covered with scales above, pubescent beneath, each joint producing a bristle.

Maxillæ setaceous, spiral, not longer than the antennæ, furnished with tentacula at the apex.

Labial palpi porrected obliquely, thickly clothed with scales, which are longest beneath and very short on the terminal joint; triarticulate, basal joint short, slightly curved, 2nd twice as long, slightly attenuated, and acuminated at the superior angle of the apex, 3rd rigid, compressed, ovate and acuminated, having a longitudinal groove on the side.

Head thickly clothed with shortish scales: *eyes* globose: *ocelli* two.

Body, thorax subquadrate, slightly crested and trilobed: *abdomen* long, robust, sometimes tufted down the back, obtuse, dilated at the apex in the males, somewhat tapering in the females.

Wings deflexed; *anterior* long, sublanceolate.

Legs strong, anterior the shortest: *femora* thickly ciliated: *tibiæ*, anterior thickly clothed with scales, concealing the internal spine, the others spurred, and furnished with a brush of scales on the outside near the middle, the posterior with two pair of unequal spurs: *tarsi* with the basal joint very long, having series of bristles beneath: *claws* bifid *.

Larva smooth, cylindrical, feeds on low plants.

Pupa folliculated; *metamorphosis* subterranean.

FAM. A.—General colour greyish white, the wings rather short, and rounded. Larva greenish, usually becoming greyish-brown before it changes to the pupa state.

FAM. B.—General colour brown, the wings longer. Larva dark coloured, dusky.

FAM. C.—Anterior wings rounded, and dark coloured; posterior yellow, with black margins. Larva whitish-gray coloured.

FAM. A. Species.	Icon.
1. Pol. *Cappa*, Hübn.....	Hübn. Noct. Tab. 95. fig. 447. (fœm.)
2. — *Chi*, Linn.........	Ernst, VI. Pl. CCXLI. f. 354.
3. — *Serena*, Fab.	Ernst, VI. Pl. CCXL. f. 352. c—f.
4. — *Dysodea*, Hübn...	Ernst, VI. Pl. CCXXXIX. f. 350. a—f.
5. — *Filigrama*, Esp...	Ernst, VI. Pl. CCXXXIX. f. 350. g—i.

* Characters from Curtis, *Brit. Ent.* VI. 248.

6. Pol.

Species.	Icon.
6. Pol. *Cæsia*, Hübn.....	Ernst, VI. Pl. CCXLI. f. 355.
7. — *Templi*, Thunb...	Hübn. Noct. Tab. 80. fig. 373. (mas.)
8. — *Polymita*, Linn...	Ernst, VII. Pl. CCCLXXIII. f. 439.
9. — *Flavicincta*, Fab...	Ernst, VI. Pl. CCXXXVIII. f. 349.
10. — *Nigrocincta*, Treitsch.*	
11. — *Platinea*, Treitsch.†	
Fam. B.	
12. Pol. *Zeta*, Treitsch.‡	
13. — *Serratilinea*, Treitsch.	Hübn. Noct. Tab. 78. fig. 365. (mas.)
14. — *Advena*, Fab......	Ernst, VII. Pl. CCLXXXIV. fig. 468.
15. — *Tincta*, Borkh. ...	Ernst, VII. Pl. CCLXXXIII. fig. 467.
16. — *Nebulosa*, Hübn.	Ernst, VII. Pl. CCLXXXIV. f. 470.
17. — *Occulta*, Linn.. ...	Ernst, VI. Pl. CCXXXII. fig. 336. Curtis, Brit. Ent. Pl. 248. Larva et Imago.
18. *Herbida*, Hübn...	Ernst, VII. Pl. CCLXXXII. fig. 465.
Fam. C.	
19. Pol. *Prospicua*, Hübn.	Ernst, VII. Pl. CCLXVIII. fig. 431.
20. — *Texta* §, Esp..	Ernst, VII. Pl. CCLXVIII. fig. 430.

Genus 59. TRACHEA, *Treitsch.*

Achatiæ, Hübner. (Achatea, Curtis.)

Wings deflexed, anterior usually variegated with lively colours; posterior ciliated; cilia generally white, or very light coloured.

Body

* Pol. alis anticis cinerascentibus, medio nigrocinctis, strigâque posticâ albis.—*Ochs. Treitsch.* V. *pars* I. 31.

† Pol. alis anticis albido-griseis splendentibus, strigis cinerascentibus obsoletis, serie punctorum nigrorum ad marginem externum.—*Ochs. Treitsch.* V. *pars* I. 34.

‡ Pol. alis anticis cæruleo-cinereis, ζ. albo notatis, fimbriis latioribus albo cinereoque variis.—*Ochs. Treitsch.* V. *pars* I. 35.

§ Cerigo, Steph.

"*Palpi* rather porrect, ascending, slightly compressed, clothed with loose hair-like scales, triarticulate, the joints of nearly equal length, the basal

Body, thorax crested, crest divided, small.

Larva, marked with broad, longitudinal bands, generally of brilliant colours. *Metamorphosis* subterranean.

FAM. A.—*Wings* broad and long.

FAM. B.—*Wings* narrow and long.

FAM. C.—*Wings* broad and short.

	Species.	Icon.
FAM. A.		
	1. Tr. *Atriplicis,* Linn...	Ernst, VII. Pl. CCLXXXII. fig. 464.
FAM. B.		
	2. Tr. *Præcox,* Linn.....	Ernst, VII. Pl. CCLXXXIII. fig. 466.
FAM. C.		
	3. Tr. *Porphyrea,* Hübn.	Ernst, VI. Pl.CCXXXV.fig.340.
	4. — *Piniperda**, Esper.	Ernst, VII. Pl. CCXCI. fig. 489. Curtis, Brit. Ent. III Pl. 117. Larva et Imago.

basal joint reniform, the next cylindric, slightly attenuated at the apex, the terminal more slender, bending outwards, and somewhat acute: *maxillæ* long. *Antennæ* elongate, setaceous, slightly pectinated to the apex in the males: *head* clothed with loose scales: *thorax* stout, a little crested behind, loosely squamous: *body* cylindric, rather long, slightly carinated on the back, tufted at the apex: *wings* horizontal, entire, *anterior* elongate-triangular, with three stigmata: *posterior* suborbiculate-triangular, usually pale yellow, with a darker hinder border."—*Steph. Illust. Brit. Ent. Haust.* II. p. 106.

Stephens considers this species as more allied in its habits to the Triphænæ than the Poliæ, from the latter of which it is readily known by its proportionately shorter and broader (anterior) wings, and by the lively colour of the posterior; and from the former it differs in the proportion of the joints of its palpi, its subcrested thorax, and dissimilar antennæ. Stephens mentions no other species as belonging to this genus.

* ACHATEA, Curtis.

" *Antennæ* inserted at the back of the head, serrated, and somewhat thickest in the middle in the males, slender in the females, composed of numerous joints, covered with scales above, hairy beneath, the basal joint large and hairy.

" *Maxillæ* long, furnished with tentacula towards the apex.

" *Labial palpi* small, very hairy, porrected horizontally, 3-jointed, 1st joint curved upward, long, robust, 2nd short robust, attenuated, 3rd minute, cylindric, truncate.

" *Head* small, nearly concealed: *eyes* small. *Thorax* large, hairy: *abdomen* robust, short, very soft, hairy beneath. *Wings* deflexed when at rest; superior obtuse, inferior rather small. *Legs,* anterior short: *tibiæ,* anterior short with a small spine on the internal side, 4 posterior terminated by spurs: *tarsi* 5-jointed: *claws* large. *Larva* naked, with 6 pectoral, 8 abdominal, and 2 anal feet."—*Curtis, l. c.*

[To be continued.]

III. *Some*

III. *Some Remarks on Mineral Veins, &c. By* R. W. Fox, *Esq.**

IT appears to be a question worthy of investigation, how far the internal structure and temperature of the earth may be connected with electricity and magnetism, and with the meteorological phænomena observable at its surface.

Both the Wernerian and Huttonian hypotheses seem to have a tendency to involve the subject of geology in obscurity, rather than the reverse; especially when applied to the explanation of the origin of veins.

How, for instance, could very *oblique open* fissures in the earth, sometimes many yards wide, and of great but unknown length and width, exist for a moment without being closed by the weight of the superincumbent mass? Besides, I apprehend that in Cornwall, at least, the width of the veins, taken in the aggregate, is not found to diminish in depth; although some of our mines have been worked to the extent of from 230 to 240 fathoms under the surface.

Veins are, however, often found irregular in their thickness at different depths; and when this circumstance and their frequently great inclination from the perpendicular are considered, it may be asked, why, if they were originally rents in the rock, they do not abound with fragments of it?

Proximate veins often unite for a certain distance, either horizontally, or in their descent, and appear to have the characters assigned to contemporaneous veins. If so, it is impossible to imagine them to have been open fissures, as the included rock would have had no support. If we suppose them to have been formed from fissures produced at different periods, it may be questioned, why the old rents, where the adhesion might be presumed to be the weakest, did not re-open? whereas neighbouring veins are sometimes not quite parallel, but often far otherwise in descending into the earth; and the direction seems to be wholly independent of the cleavage or dip of the containing rocks; and in fact they pass through different rocks, such as granite and clay-slate, without suffering any alteration in their course at the place of junction.

But if it should be admitted, for the sake of the argument, that such open fissures as have been alluded to, *could* exist, and that the substances found in veins *could* all be held in solution, and *might* be deposited in the actual forms and combinations in which they are now found,—there is nothing like horizontal stratification to be seen even in the largest veins; and

* Communicated by the Author.

the commonly smooth surfaces of their containing sides, or "walls," and the rarity of stalactitical forms in them, equally forbid the idea of the contents of veins having once flowed down their sides or exuded from them. Nor are there any instances that I am aware of, of even the smallest veins, however great their inclination, exhibiting extensive open fissures, in consequence of the upper part being closed up or choked by depositions from above.

It may be remarked, that the contents of veins are not arranged according to their specific gravity, the metalliferous ores being commonly found in detached masses, sometimes near the surface only, and at other times at considerable depths, or they are dispersed in the veins at various depths. Frequently, ores of different kinds, which would combine immediately if in fusion, are found in contact, but in entirely distinct masses. Many of these combinations would be instantly decomposed by a great degree of heat; and clay, which is so prevalent in veins, cannot be supposed to have an igneous origin.

Thus I think it may be asked, if the theories which have been advanced on this subject be calculated to remove some difficulties, do they not substitute greater in their stead?

The curious arrangement of veins, and the geological structure of the earth, seem to me to afford ample evidence of *design;* and I cannot but believe that the operations of Nature under the surface, as well as above it, are intimately connected, and that they equally derive their origin from Divine wisdom and creative power.

It is a very remarkable fact, that veins are in a considerable degree, either coincident with, or at right angles to the magnetic meridian.

In Cornwall and Devon, copper and tin veins are instances of the latter; and those of clay, quartz, &c. of the former. Lead and silver ores, &c. are usually found in north and south veins, when they occur in the neighbourhood of those of copper and tin. In some parts of Cornwall, however, instances have occurred of lead veins assuming nearly the E. and W. direction, but I am not aware that any copper and tin veins are known to exist in their immediate neighbourhood. I believe the lead veins generally run from about E. to W. in Wales, and in some parts also of the North of England. This is likewise the prevalent direction of the great silver veins in Mexico. The same observation applies to the veins in many mining districts in Europe.

This may be taken as the most common direction of the principal metalliferous veins in different districts, as far as my information

information extends; and I believe the fact of some other metallic ores being arranged at right angles to the former, is not peculiar to Cornwall.

In the latter district the E. and W. veins are usually intersected and broken by the cross veins; and instead of being continued in straight lines, the parts are more or less widely separated. And as the cross veins commonly consist of clay or quartz, or of both together, the insulation seems almost complete as it respects water and *electricity*. The clay being found to dam up the water effectually even in the immediate neighbourhood of deep excavations; and the quartz, which is an imperfect conductor of electricity, appears to me to be rendered more effectually so by its radiated texture,—a formation which I believe is peculiar to quartz found in cross veins. Sometimes the quartz is on one side of the clay, and in others included in the middle of it.

Nor must I omit to allude to veins of another kind (if they may be so termed), which more easily approach an horizontal position, and are usually in an E. and W. direction, and are called "slides" by the miners, from their separating the veins at different depths under the surface. These slides are also mostly impervious to water.

There seems, in fact, to be a remarkable analogy between the arrangement of veins and some electrical combinations. The high temperature of the earth varying as it seems to do at different places, and the salts contained more or less in water, tend to strengthen the resemblance.

The arrangement of ores in the veins also affords evidence, I think, in many ways, of the presence of electricity, either as *cause* or *effect*. I may instance the regular disposition and aggregation of different kinds of ores in the same veins, and the frequent accumulation of metallic ores in parallel veins in places at right angles to their direction *.

The principal mining districts in Cornwall are usually near the places of junction of granite and clay-slate.

It has been observed that nearly parallel E. and W. veins often become more productive when they unite either horizontally or in depth, and the reverse frequently happens when veins descending into the earth at *opposite* inclinations intersect each other.

Instances are occasionally, but very rarely, met with of E.

* My friend R. Tregaskis, of Perran, near this place, who is well acquainted with the practical part of mining, has remarked to me, that veins are usually found most productive of ore near the intersection of cross veins, and I believe this observation to be well founded.

 and

and W. veins intersecting the cross veins without suffering interruption.

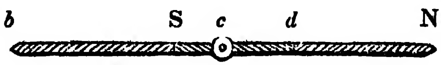
The great veins or dykes of porphyry, or *Elvan courses* as the miners term them, may also be connected with electrical action. They are nearly in an E. and W. direction, and are not affected by the veins which cross them.

I need not say that the above is a very summary and imperfect statement of some of the phænomena of veins; and I cannot but believe, that a more minute investigation and complete classification of facts than has yet been attempted, relative to this important branch of geology, would be interesting to the philosopher, and perhaps valuable to the miner. This object might, I think, be best attained by scientific individuals, or societies, employing a suitable person who would devote his time and attention to the subject. He might also try various experiments, especially with the magnetic needle, near the junction of different rocks, and in the vicinity of veins having different directions, to ascertain if the variation or the magnetic intensity is affected thereby.

With the view of making some experiments hereon, when I can find sufficient leisure for the purpose, I have had some magnetic needles prepared with one polarity only in action; the other being neutralized, or nearly so, by altering the centre of suspension to within the neutralized pole itself, and extending it with brass as a counterpoise to the acting pole*.

If it should prove that veins differently circumstanced have different effects on these needles; may it not tend to explain the cause of the periodical variation of the compass, if we suppose electrical action to vary in its relative intensity at different periods of time? And may not electricity, the intensity of which varies so continually in the atmosphere, affect the oscillation of the pendulum and cause the discrepancies observable, especially when the pendulums are insulated, or only partially so, on agate edges?

* To make the above description more intelligible: Suppose N S to be the magnetic steel; S *b* an addition to the steel, made of brass or some other metal not affected by magnetism, to act as a counterpoise to the opposite arm; *d* the centre of the steel part of the needle where magnetic neutralization takes place. It is evident that *c*, the centre of suspension, can be so placed that the two arms *c* S, *c d* having south polarity, may counteract each other, and leave the north polarity *d* N to its full action; or the case may be reversed, by substituting the S pole for the N. Would it not be interesting to make experiments with these needles on the magnetic intensity at different places, and in different latitudes?



I may

I may also just remark, that the rotation of the earth on its axis from W. to E. appears somewhat analogous to certain phænomena in electro-magnetism.

Geology has perhaps hitherto been considered too much as an insulated science; whereas, I believe that the phænomena it embraces are only additional links in the chain of creation, so intimately connected in all its parts. Otherwise it must be admitted to present an anomaly when compared with the other works of the Deity, in the minutest portions of which, order, wisdom, and reciprocal dependence become more and more evident in proportion as they are investigated.

ROBERT W. FOX.

IV. *Description of a Parabolic Sounding Board, erected in Attercliffe Church. By the Rev.* JOHN BLACKBURN, *M.A., late of St. John's College, Cambridge; and Minister of Attercliffe-cum-Darnall* *.

[With a Plate.]

IN the year 1826 a new church was consecrated at Attercliffe, near Sheffield; being built according to a design by the late T. Taylor, Esq., by means of a grant from His Majesty's Commissioners appointed under the Act for the building and promoting the building of additional Churches.

The area of the interior is in the form of a rectangular parallelogram, 95 feet by 72. At the east end is an elliptical recess 32 feet wide and 10 feet deep, making the extreme length of the centre line from east to west 105 feet. The roof is vaulted and groined; the highest point in the ceiling of the nave about 56 feet from the plane of the floor: there are galleries at the sides and at the west end.

In this church the resonance was powerful, but the sound indistinct and confused, whatever was the character of the voice from which it proceeded: no exertions, no pains on the part of the speaker could render him audible. To remedy this most serious inconvenience, various unsuccessful experiments were made. The pulpit was removed to different points; and although its present situation proved the best †, the evil complained of still remained: the common horizontal sounding board was tried, which conferred indeed a benefit on a few seats about the pulpit, (seats which least of all re-

* Communicated by the author.

† The pulpit stands in the middle aisle, 15 feet in advance of the altar rails; its form is octagonal; its floor 9 feet above the floor of the church; the ascent is by a winding staircase, with the door on one side; in front are the reading-desk and clerk's-desk.

quired

quired such aid,) but its general effect was so decidedly disadvantageous, that it was again taken down *.

The desired object was to convey a distinct sound to *remote* parts of the church: under the impression that this might be attained by intercepting so much of the sound as escaped behind and echoed in this part of the vaulted roof; as also by giving it a right direction; and conceiving that a parabolic figure might be so applied as to answer these ends, the writer of this paper made the trial; and the issue has more than realized his hopes and expectations.

Grateful for this result, believing that the *application* of the principle was new, hoping to awaken the attention of others better qualified than himself (for he does not pretend to much mathematical science or knowledge of acoustics), and induce them to pursue the investigation of this interesting and important, but perhaps neglected, subject,—he addressed a paper to the Royal Society, which was kindly received and honoured with a place among the records of that distinguished institution. Since this communication to the Royal Society, inquiries having been made in every variety of form as to the construction and effect of the parabolic sounding board, a more detailed account is now presented to the public, as the most effectual means of supplying the information required. Those who wish to satisfy themselves by personal view will receive every attention.

The material is pine wood. The surface is concave, and is generated by half a revolution of one branch of a parabola on its axis.

The distance from the focus to the vertex = 2 feet.
The length of the abscissa is . . . . = 4 feet.
The length of the ordinate to the axis . = $\sqrt{32}$ feet.
= nearly 5.7
= rad. of outer circle.

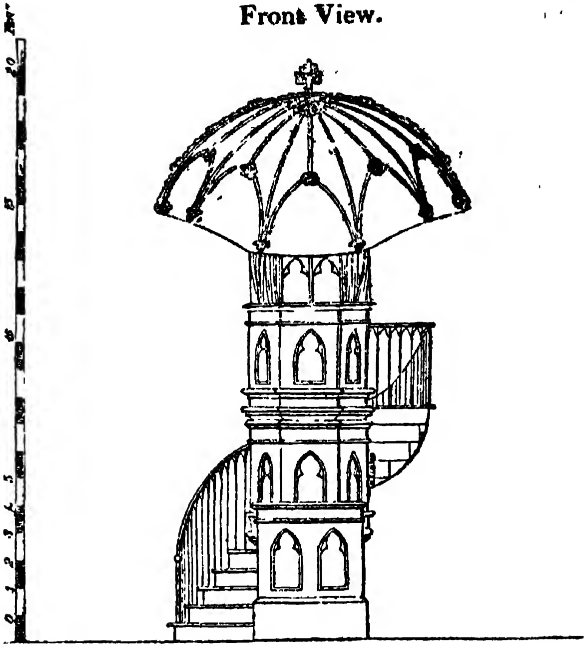
The axis is inclined forwards to the plane of the floor at an angle of about 10 or 15 degrees, and elevated so as that the speaker's mouth may be in the focus.

A small curvilinear section is taken away on each side from beneath, that the view of the preacher from the north and south galleries may not be intercepted; whence the outer semicircle is imperfect.

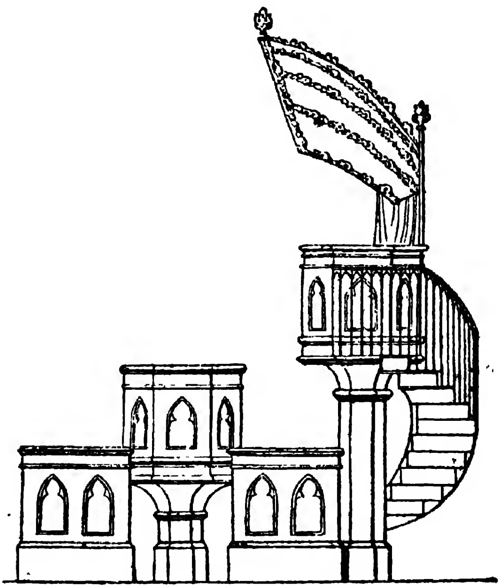
* This follows of course, on the principle that the angle of incidence is equal to the angle of reflection; and yet the horizontal board is that always in use: whence many persons have assumed that no sounding board could be adopted with advantage in any church.

No. 1.

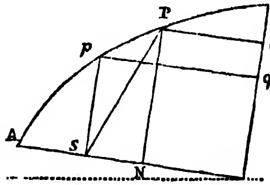
Front View.



Side View.



This, however, gives an appearance that is not inelegant; and the outer edge being ornamented with crockets and leaves and with a finial at the highest point, and the concave surface being painted in imitation of a groined oak canopy, the effect of the whole is pleasing to the eye. A curtain is suspended from the lower edge of the canopy for about 18 inches on each side; the object of this is to intercept the sound which would pass beneath the sounding board, and might create a confusion behind: but to press it into the service as proposed hereafter is of course to be preferred.



By means of this erection the volume of sound is increased in a very considerable ratio, and is thrown powerfully, as well as distinctly, to the most distant parts of the church; so that whereas formerly the difficulty of hearing an intelligible sound was very great, now that difficulty is effectually removed.

The preacher was scarcely audible even in the pews near the pulpit, and not at all in those more remote: he may now be heard in every part.

It should seem that the voice is reflected in a direction parallel to the axis; for let A stand in the pulpit, and B stand first in the west gallery opposite to the pulpit, and then in the side galleries; though B is much nearer to A in the latter case than in the former, he can yet hear with decided advantage when opposite to A (i. e. at the greater distance from him).

The side galleries appear to be benefited rather by the increased volume of sound, and by the secondary vibrations excited in a lateral direction.

It appears also that vibrations proceeding from a distant point and moving in the direction of the axis, are reflected from the parabolic surface towards the focus. For let A stand in the pulpit as before, and B in a distant point opposite to A, A can then converse with B in a whisper; whilst C, standing at an intermediate point, cannot at all distinguish the words spoken by B; he can however hear what is said by A. Also if B, at a distance, opposite to the sounding board, speaks; whilst A places one ear in the focus of the parabola and one ear towards B, the effect produced is that of a voice close to the ear, and in a direction the reverse of that from which it really proceeds.

The converse of this also appears true from the following experiment.

Let

Let B remain in the situation last supposed, and let A place his face towards the parabolic surface, and his back towards B; let A now speak, having his mouth in the situation of the focus, and he will be heard as distinctly as when his face was turned towards B.

If the mouth of the speaker is placed much within or without, above or below the focus, the effect is proportionably diminished. It has been asked if the speaker must necessarily be confined to one point: to this it may be replied certainly not. He may consult his ease, and will still find the advantage of the canopy over his head; but as his mouth approaches the focus, an attentive hearer will perceive an effect that may not unaptly be compared to the gentle swell of an organ (*parvis componere magna*). The greater the distance between the focus and the vertex, the less will this variation be perceived.

This sounding board is equally well adapted for a strong or weak voice; the latter acquires strength, whilst in both cases distinctness of articulation is preserved: this may perhaps in some measure be accounted for thus. Assuming that the sound issuing from the focus is reflected in a direction parallel to the axis; assuming also that the velocity of sound is uniform; then the vibrations of the air proceeding from the focus and striking the parabolic surface, at whatever point, will arrive at the same moment of time at a plane perpendicular to the axis. For (according to the properties of the parabola) the sums of the distances (from the focus to the paraboloid, and from the paraboloid to the plane so situated) are always equal to each other: it must however be admitted, that the velocity of sound is too great to allow much dependence to be placed on this conclusion; but it is here proved beyond dispute, that a parabolic surface is capable of being successfully applied to the purpose of a sounding board: whether other concave surfaces similarly situated would be equally successful*, or other materials better adapted to answer the end than pine†, it might be worth while by experiment to ascertain. It is clear that unless the sounding board be constructed with mathematical nicety and placed with mathematical precision, much of the effect will be lost.

Whilst the figure of the canopy remained perfect, the effect was most complete: perhaps it might be improved if constructed larger, or in other words, if continued further in

* Many persons have expressed a preference for the hyperboloid, as giving a divergency to the rays: one friend has proposed a logarithmic curve.

† Some have suggested stone, or a frame-work covered with Roman cement; because such a piece of work would not vibrate, and consequently would not counteract the vibration of the air, on which the sound depends.

advance; but the distance from the focus to the vertex (which regulates the curve) must depend on the supposed situation of the speaker, which will vary according to the diameter of the pulpit.

The outline, No. 2, represents an improved parabolic sounding board, formed by an entire revolution of the parabola on its axis, with pulpit, reading-desk, and clerk's-desk, according to a model designed and arranged by the writer of this paper, and deposited with the Society of Arts, together with a model of sounding board, No. 1.

The ornamental parts may, of course, be adapted to the character of the building in which it stands: the altar table might be placed in front.

The reflection of sound from the lower part would take the same direction as that from the upper, viz. parallel to the axis: and the effect would probably be much more than double that produced by sounding board, No. 1. Many improvements may still doubtless be suggested.

In erecting a new church, might it not be found most advantageous to give to the east end of the building itself the form of a paraboloidal concave, and to place the pulpit in the focus?

The sounding board, No. 1, was thus constructed. The curve was first drawn according to the following method:— On the straight line LN (fig. 6.) make LA = AS = SN. At the point A draw AB perpendicular and equal to AL. Join LB. Produce LB to C. Divide AN into any number of equal parts in *a*, *b*, *c*, &c.; and at *a*, *b*, *c*, &c. draw *aa*, *bb*, *cc*, &c. parallel to AB, and meeting LC in *a*, *b*, *c*, &c. Let straight lines = AB, *aa*, *bb*, *cc*, &c. revolve round S as a centre, intersecting AB, *aa*, *bb*, *cc*, &c. respectively in A, *p*, *q*, *r*, &c. Join A, *p*, *q*, *r*, *s*, *t*, &c., and the curve traced out will be a parabola; of which A will be the vertex, S the focus, AN the axis. The distance between the speaker's mouth and the back of the pulpit being 2 feet = AS = SN = AL.

Another method is subjoined, being taken from the Mechanics' Weekly Journal, No. XXIV.

"The parabola being the curve that is best adapted for the reflection of heat, and of course requisite for the formation of metallic mirrors, covings of chimneys, and cupolas of melting furnaces; an easy method of describing it, adapted to the comprehension of workmen, was wanted.

"Mr. Leslie, in his 'Enquiry into the Nature and Propagation of Heat,' having occasion for metallic mirrors, described the gauges for them in the following manner.

"Let AB (fig. 7.) denote the extreme breadth, and CD the intended

intended depth. Divide AB into 20 parts, and draw perpendiculars from each division. Consider the depth CD as equal to 100. Make the next ordinate, or perpendicular, or either side equal to 9 multiplied by 11, that is to say 99, by the same scale; which is easily done by the line of lines on a sector rule: the next ordinate on either side equal to 8 multiplied by 12, that is to say 96; and so on. These numbers being respectively as the rectangles of the segments into which CD is divided."

A scaffolding was made of three semicircles (fig. 4.), KL, MN, PZ; fixed perpendicular to the axis of the parabola; the axis passing through their centres. This done, three parabolic sectors (fig. 1.), AB, AC, AD, were cut out of three-inch pine and placed as in fig. 1., pointed at the bottom; these were let into two cross ribs, EF, GH, cut out of tough wood naturally bent (to avoid crossing the grain), and dovetailed at each end to keep the three sectors firm and in their place: the spaces between IC, CB, BD, DK, were filled up with sectors cut out of 1½ inch wood, nailed and glued well together: lastly, the inside was cleaned off and proved by the sector (fig. 6). At regular distances, three iron plates or bands were let in (both inside and outside), well fastened with screws. The horizontal edge IAK was finished with two sectors of hard wood; and the back strengthened where the points chiefly met, with a tough piece of inch board; where also the sounding board was fastened to the pulpit-back with screw-bolts and nuts, being further supported near the centre of gravity by an iron rod suspended from the ceiling above.

The wood was well seasoned, and placed beside a furnace for six weeks; the sounding board has been fixed for nine months, and has not been affected by weather.

Figs. 2 & 3 represent the cross ribs EF, GH in fig. 1.

Fig. 5 represents a parabolic sector whose *concave* is that required.

Fig. 6 represents a parabolic sector whose *convex* answers to the concave of fig. 5; and is used to prove the work when done, being applied at the point A, and turned on its axis AZ.

Attercliffe Parsonage, near Sheffield,
February 28, 1829.

V. *An Attempt to improve the Natural Arrangement of the Genera of Bat, from actual Examination; with some Observations on the Development of their Wings.* By J. E. GRAY, *Esq. F.G.S. M.R.S.L. M.Z.S. &c.**

IN the Zoological Journal, vol. ii. p. 242. some time ago I attempted to divide the Bat into two natural groups; and these groups have been adopted, without acknowledgement, by M. Lesson in his *Manuel.* But since that time having had the opportunity of personally examining several genera which I had not then seen, and having profited by the observation which Temminck has made on the variations which take place in the number of the cutting and other teeth of Bats, which I have the power of verifying myself, I have been induced to study again the characters of the genera and their groups: and in the hopes of facilitating the study of this universally acknowledged difficult subject I send you an abridgement of my observations. The genera of Bats have been almost entirely formed from the study of the number and position of the cutting teeth and grinders. Temminck has lately proved, by the examination of several specimens in different stages of growth of the same species, that these characters chiefly depend on the age of the individual examined; and by this means he has been enabled to abolish several of the genera established by Geoffroy, and acknowledged by the other French naturalists: and I have been enabled, by the opportunities which I have had of examining several of the specimens which served Dr. Leach as the type of his new genera, to arrange them with their allies, and in most instances to prove that their advancement to the rank of genera was owing to their being examined in a dry state, and to the particular age of the specimens under examination. The French naturalists have paid some attention to the peculiar form of the ears of some of the Bats,—an organ which appears to give most excellent characters: but their descriptions have been very vague, certainly not taken from the examination and comparison of the ears of the various genera; for thus, in Desmarest's description of the ear of the genus *Nyctinomus* and *Molossus*, he must have mistaken the *lobule* for the *tragus* or *oreillon*, and have overlooked the true tragus, which is certainly very small, and sometimes nearly wanting, but very similar to those of the genus *Noctilio*, where he has correctly described them; and in the genus *Glossophaga*, the description of the ears has been entirely omitted.

Several genera have been established on a slight variation in the

* Communicated by the Author.

the number of the grinding teeth, without any other external or zoological character. These I have not adopted; as the front grinders are often deciduous: and their number not being to be seen without destroying the animal, renders them almost useless to the zoologist, and such genera certainly do not facilitate the study of zoology.

Sect. I. ISTIOPHORÆ.—Nose furnished with a leaf-like appendage. The teeth acutely tubercular. Index-finger not clawed.

Fam. 1. RHINOLOPHINA.—Nose-leaf complicated, pierced by the nostrils and with a central lobe?—Wings large, interfemoral membrane large.—Index-finger of only one bony phalange, the others supplied by cartilage.—Ears moderate, the upper and lower margin of the conch united together, the antehelix rib-like thin, the lobule spread out. Tragus none; antetragus keeled.—Tail long, enveloped, inflexed.—Cutting teeth small, deciduous, and distant from the canine; lower more crowded. The female provided with pubal as well as pectoral teats.

1. Rhinolophus, *Geoff.* Inhabits the Old World.

Fam. 2. PHYLLOSTOMINA.—Nose-leaf simple, pierced by the nostrils, which are generally covered by one or two valves.—Wings large, interfemoral membrane often wanting or large.—Index-finger of two long phalanges. The conch of the ear simple, often very large and united together, the upper and lower margin separated, distant. The antehelix rib-like, the tragus distinct, often serrated; the antetragus indistinct.—Lobule thin, inflexed.—Tail often wanting, sometimes long.—Cutting teeth 2 or 4 above, and 4 or 6 below. Some of the genera have pubal teats.

* *Interfemoral membrane short; tail none, or short, free.*

2. Phyllostoma.—Ears distant. Cutting teeth $\frac{4}{4}$, crowded; upper two central largest, lateral ones deciduous. Lips fringed. Tongue short. Tail none, or very short, free.—The genera *Monophyllus*, *Artibeus* and *Medateus*, of Dr. Leach. *Diphydia* of Spix does not differ from the above. The genus *Vampyrus* of Geoffroy, only differs in having an additional grinder on each side of the lower jaw.—They are confined to the warmer parts of America. The genus *Desmodus* of Pr. Max. (Anim. Braz.) appears only to differ in having the "Museau couvert à sa pointe de plusieurs crêtes nasal."

3. Glossophaga. — Ears distant. Tail very short or none. Lips not fringed; lower cut. Tongue long, bristly. Cutting teeth $\frac{2:2}{2:2}$ very small.—Found in America.

** *In-*

** *Interfemoral membrane short. Tail long, end free.*

4. Rhinopoma. *Geoff.*—Ears united over the forehead. Forehead with a deep concavity. Tail long, end free. Nose-leaf simple; nostrils covered with a small valve. Cutting teeth $\frac{2}{4}$. Pubal teats distinct.—Found in the warm parts of the Old World.

*** *Interfemoral membrane long. Tail inclosed in the membrane or none.*

5. Mormops, *Leach.*—"Ears distinct, confluent with the nose-leaf. Tail half as long as the interfemoral membrane, end free. Cutting teeth $\frac{4}{4}$." *Leach.* Found in America.

6. Megaderma, *Geoff.*—Ears very large, united over the forehead, lobule inflexed. Tragus deeply cut. Tail none. Cutting teeth $\frac{0}{4}$ when old.—Found in India and Africa.

7. ?Nyctophilus, *Leach.*—"Ears large, united. Tail produced to the end of the interfemoral membrane of 5 exserted joints. Cutting teeth $\frac{2}{6}$." *Leach.* Dr. Leach described the index-finger as having but one joint; but he has described *Monophyllus* as having the same formation, when actually the specimen he described has two; therefore I have ventured to place it in the family.

8. Nycteris, *Geoff.*—Ears large, united. Tail as long as the interfemoral membrane, ending in a forked cartilage. Forehead with a deep groove. Nostrils closed by a cartilaginous valve. Cutting teeth $\frac{2.2}{6}$. Found in Africa. I have a bat said by Temminck to belong to this genus; but I can see no characters to distinguish it from *Vespertilio.* Its only peculiarity is the great length of the spurs of the *ossa calcis,* which is certainly only a specific distinction. Geoffroy represents a small double nasal leaf.

Sect. II. ANISTIOPHORI.—Nose simple, without any leaf-like appendage.

* *Teeth acutely tubercular, index-finger clawless.*

Fam. 2. VESPERTILIONINA.—Head small.—Face nakedish.—Ears: concha thin, upper and lower edge separated by a short space.—Antehelix and antetragus rib-like.—Lobule thickened, tubercular.—Tragus large, long, mostly entire.—Wings large, and long.—Index-finger of two bony joints.—Tail long, enveloped in the large interfemoral membrane.—Feet small.—Toes nearly equal.—Cutting teeth, when young, $\frac{2.2}{6}$, upper ones in pairs near the

the canines, with an intervening space; the front ones long, conical, hinder small, often deciduous; and sometimes entirely wanting; the lower small, close-set.—Eating insects.

* *Tail inclosed in the interfemoral membrane.*

9. BARBASTELLUS, *Gray.*—Ears large, united in front. Tragus long. Nostrils with a short membranous crest behind them, and the forehead with a naked erectile? Longitudinal fold in the skin.

B. —— n. s. and perhaps Vespertilio Barbastellus, *Linn.*

10. PLECOTUS, *Geoff.*—Ears very large, united in front. Nostrils and forehead simple. Tail jointed to the end of the prolonged interfemoral membranes. Cheek-pouches none.—*P. auritus.* The genus *Nycteris* of Geoffroy appears to be very like this genus.

11. VESPERTILIO, *Linn.* — Ears separate, conical, lateral. Nostrils simple. Forehead hairy. Tail with distinct vertebræ to the top of the produced interfemoral membrane. Cheek-pouches large?—The genera *Atalapha*, *Nycticeus*, and *Hyperodon* of Rafinesque depend on the deciduous nature of the teeth. The genus *Nyctalus* of Bowdich (Voy. Mad. 36), is only a *Vespertilio*, with ticks in the ears! and I believe his African *Pteropi* (p. 221) are only true bats in which he mistook the thumb for the index-finger, as he did in the above genus.—The genus *Scotophilus* of Leach is a Vespertilio, one of the largest species of the genus; his description of the bones of the finger does not agree with Mr. Brookes's specimen.—Inhabits all parts of the world.

12. FURIA, *F. Cuv.* not *Linn.*—"Ears large, separate. Interfemoral membrane produced. Tail with distinct vertebra only half the length of the interfemoral membrane, the rest cartilaginous. Cheek-pouches none." *F. Cuv.*—Inhabits South America.

** *Tail bare, inclosed, and free on the upper side of the membrane.*

13. PROBOSCIDEA, *Spix.* — Emballonura, *Kuhl.?* — "Ears small, lanceolate, distinct, adpressed. Tragus lanceolate, entire. Lobule tubercular. Head acute; nose long. Cutting teeth $\frac{4}{6}$, upper near the canines. Wings short, wide. Tail half enveloped, end free on the upper surface of the short interfemoral membrane; spurs long." *Spix.*—This genus, which I have never had the opportunity of examining, appears to unite the two subfamilies, having

having the teeth of *Vespertilionina*, and the tail and wings of *Noctilionina*.

——— ?

*** *Tail very short, covered with bony valve.*

14. Diclidurus, *Pr. Max.*—No character. "Ears short, broad. Tragus ——— ? Wing long. Arms very long and strong. Tibia long and thin. Spur long. Tail composed of two concave horny plates; the lower triangular and acute, fitted to the other, of a larger size.' *Pr. Max.* Diclidurus Freyreissii. *Pr. Max.* the *D. albus. Isis* 1819, p. 1629. From the figure the interfemoral membranes appear to be large and truncated.

Fam. 3. NOCTILIONINA.—Head large.—Face nakedish.—Lips large pendulous, often grooved or warty.—Ears: Concha thick, leathery, often large and folded. Helix thickened, interrupted in front. Antehelix and antetragus costate, often very distinct: lobule thickened, tubercular. Tragus small sometimes reduced to a small tubercle, placed deep in the meatus auditorius.—Wings small.—Index-finger of two long joints; the membranes sometimes arising from near the centre of the back, so as to leave a deep nursing-pouch on each side.—Thumb short thick interfemoral membrane generally truncated.—Tail thick, end free, either beyond or on the upper or lower surface of the membrane.—Feet large, great toes largest, sometimes opposible.—Cutting teeth very variable, $\frac{4}{4}$, or $\frac{2}{2}$ or [illegible]; upper teeth near together in the front of the mouth, leaving a space between them and the canines; sometimes wanting; the lower small.—Eating insects.

Tail, end free on the upper surface.

15. Noctilio, *Geoff.*—Ears separate, distinct, small. Antehelix small. Tragus linear, dentated. Forehead simple. Cutting teeth $\frac{4}{2}$ or $\frac{2}{2}$. Tail short, enveloped. Tip produced on the upper surface of the truncated interfemoral membrane. Perhaps *Cœlano* of Dr. Leach, will form part of this genus; was it not established from *N. unicolor* of Geoffroy?

16. Taphagous, *Geoff.*—Ears separate, distinct, small, drooping. Antehelix indistinct, lobule spreading. Tragus short, blunt. Cutting teeth $\frac{0}{4}$. Forehead with a concavity. Tail half enveloped, end produced on the upper surface of the long truncated interfemoral membrane.

** *Tail base enveloped, end produced beyond the interfemoral membrane.*

17. Cheiromeles, *Horsf.*—Ears separate, distant, small. Antehelix?

Antehelix ——? Tragus ——? Cutting teeth ——? Tail bare, partly enveloped in the short interfemoral membrane. Great toe large, opposible.

18. Dysopes, *Illig.* not *F. Cuv.* — Ears large, pendant, united over or close together on the forehead. Antehelix and antetragus large, distinct; lobule tubercular, large; tragus small, sometimes reduced to a point. Cutting teeth $\frac{2}{1}$. Face large, lip thick, grooved. Tail base enveloped with the short interfemoral membrane; end free.—This genus includes the genera *Dinops* of Savi, *Nyctinomus* and *Mollossus* of Geoffroy, and perhaps *Thyropterus* of Spix, and *Stenoderma* of Geoffroy.

**

? 19. Myopteris, *Geoff.* — "Ears separated, distinct, small. Tragus small. Cutting teeth $\frac{2}{2}$. Tail half enveloped."—*Geoff.*

**** *Tail attached, half as long as the membrane.*

20. [illegible]llo, *Leach.*—"Ears approximating, short, very broad. Tragus none. Cutting teeth $\frac{2}{2}$. Tail attached, half as long as the large interfemoral membrane. Limbs long." I have not had the opportunity of examining the two latter genera. The genus *Dysopes* of F. Cuvier, which probably belongs to this group, has only been established from the examination of a cranium.

Teeth blunt, only tubercular. Tragus none. Index-finger often clawed.

Fam. 4. PTEROPINA.—Head long, conical.—Nose end two cut, nostrils tubular; lips small.—Ears. Concha moderate, thick, conical, lateral edges united in front so as to form a conical meatus auditorius without any distinct tragus or convolutions.—Wings large, with a broad membrane uniting the thumb, so that the fingers and thumb form a cone, when expanded. The index-finger of three bony joints generally ending in a sharp claw. Thumb long, membrane often arising from near the centre of the back. Interfemoral membrane very short, sometimes wanting. Tail very short, sometimes deficient.—Cutting teeth.—Feet long.—Toes nearly equal.—Eating fruit, congregating together.

21. Pteropus, *Geoff.*—Index-finger clawed. Tongue short. Head moderately long. The genus *Cynopterus* of F. Cuvier only differs in having a grinder less on each side; and every true zoologist must allow that it is not for the benefit of science to adopt such genera.—Inhabits India and Polynesia.— The African and Madeira *Pteropi* of Bowdich appear to be *Vespertiliones*.

22. Macroglossus, *F. Cuv.* not *Fab.*—Index-finger clawed. Head very long. Tongue very long, extensile.

23. Harpya, *Illig.* — Index-finger clawless. Head short; membranes of the wing arising from the dorsal line: containing part of *Cephalotes* and *Pteropus* of Geoffroy.

The genera of these animals being almost proverbially difficult to distinguish, I have been induced to draw up the following Tables, in the hope of facilitating the inquiries of the Zoological student.

1. Interfemoral membrane large, extended. Tail, none. 6. *Megaderma.*

2 Interfemoral membrane large, extended. Tail formed of two bony valves.. 14. *Diclidurus.*

3. Interfemoral membrane large, extended. Tail only half as long as the membrane, and more or less attached to it.
Nose complicated .... 5. *Mormoops.*
Nose simple.
Tail soldered to the membranes.
Ears distant .... 12. *Furia.*
—— close together.. .... 20. *Ællo.*
Tail end free above the membranes.
Head long, acute .... 13. *Proboscidea.*
—— conical, blunt.
Forehead simple .... 15. *Noctilio.*
———— pierced .... 16. *Taphagous.*

4. Interfemoral membrane large, extended. Tail as long as the membrane, and attached to it.
Nose with leaves.
Ears simple .... 1. *Rhinolophus.*
—— united.
Tail end conical .... 7. *Nyctophilus.*
——— forked........................... 8. *Nycteris.*
Nose simple.
Ears simple .... 11. *Vespertilio.*
—— united.
Forehead hairy .... 18. *Plecotus.*
? ———— naked.......................... 9. *Barbastellus.*

5. Interfemoral membrane short, tail more or less long, attached at the base to the membrane, and extended beyond it.
Nose leafed, forehead pitted .... 4. *Rhinopoma.*
—— simple.
Ears distinct.
Great toe ——?.......................... 19. *Myopteris.*
———— large, opposible .... 17. *Cheiromeles.*
Ears close together, drooping............ 18. *Dysopes.*

Interfemoral membrane none or very small. Tail none, or very short and free.
Nose leaved.
Lips fringed. Tongue short............... 2. *Phyllostoma.*
—— not fringed. —— long................. 3. *Glossophaga.*
Nose simple.
Index-finger clawed,
Head conical .... 21. *Pteropus.*
—— very long .... 22. *Macroglossus.*
Index-finger clawless......................... 23. *Harpya.*

In

In a late visit to the College of Surgeons, I was much struck at observing the small size of the wing of the Fœtuses of *Pteropi*, compared with these parts in the adult animal; and on continuing the examination I found that the same difference of development appeared to take place in the other genera of bats.

These differences in the relative development of the fore and hind extremities appear to have escaped the observations of Temminck and other modern writers on this family of animals; it is of the more importance, as several of the writers on this subject have been induced to place great reliance on the proportions of these parts compared with the size of the body in their specific descriptions. Indeed, in the last part of the Linnæan Transactions, the Rev. Mr. Jenyns, who is certainly a very acute observer, and who has paid great attention to the bats of this country, has been induced to describe a bat as a distinct species, which only differs in the relative measurement of these parts, under the name of *Plecotus brevimanus;* and which from the examination of a specimen in the collection of the Zoological Society, named by the author, I am induced to think is only the very young state of *Vespertilio auritus*, as I had named the specimen when I was assisting in making the catalogue of the Mammalia and Reptiles of that collection.

I shall give a description of the young state of *Pteropus**, as I have been enabled to see three specimens, in different stages, of an apparently undescribed species, which were discovered in the late expedition under Captain Beechy, which I refrain from describing, as Mr. Lane, the naturalist of the expedition, informed me that he intended soon to describe it in another journal.

The Fœtus of the *Pteropus* (cut from the body of the mother) has a large head, and small arms: and wings with a large longly clawed thumb. The hind legs and claws are also very large and perfectly formed. These peculiarities are easily accounted for when the habits of the young bat are considered; for in the young state they do not require the use of their wings, but rest attached to the sides of their mother, and for the purpose of holding themselves on, they are provided with large and well-clawed thumbs and feet, allowing the wings to gradually develope themselves.

In a visit which I lately paid to Haslar Hospital, at Portsmouth, for the purpose of examining the Mollusca brought home, and so well described by the collector, the surgeon of the expedition, I was fortunate enough to discover a very

* *Pteropus pselaphon*, Lay, Zool. Jour. vol. iv. p. 457.

young specimen of this animal, which was intermediate in the relative size of the wing between the fœtal and the perfect state of the animal.—The following Table exhibits the measure of the same parts of the specimen in the three stages of growth; but as the measurements were taken at three very different times and places, they do not all exactly correspond. The measurements are in inches and parts:

Pteropus pselaphon.	Fœtus.	Young.	
Length of body and head	$3\frac{1}{2}$		$9\frac{1}{2}$
Antebrachium....................	$1\frac{1}{4}$	2	5
Index finger......................	1	$2\frac{1}{2}$	$3\frac{3}{4}$
Middle finger	$2\frac{1}{2}$	$3\frac{1}{2}$	$9\frac{3}{4}$
Ring finger........................	$1\frac{1}{2}$	$2\frac{1}{2}$	$7\frac{1}{2}$
Little finger........................	$1\frac{1}{4}$	$2\frac{1}{3}$	$6\frac{1}{2}$
Thumb................................	$\frac{3}{4}$	1	$1\frac{1}{2}$
Thumb-claw........................	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
Thighs	$\frac{1}{2}$	$\frac{3}{4}$	
Legs....................................	$\frac{3}{4}$	1	
Hind feet............................	$\frac{3}{4}$	$1\frac{1}{4}$	
Expanse of the wings............			

VI. *On the Bituminous Schist and Fossil Fish of Seefeld, in the Tyrol.* *By* Roderick Impey Murchison, *Esq. F.R.S. Sec. G.S. F.L.S. &c. &c.**

THE village of Seefeld is situated at the summit level of the principal road from Inspruck to Munich, where it traverses one of the most northern ridges of the Rhetian Alps. This range of mountains is chiefly composed of dolomite; but the middle and lower members of it, about $2\frac{1}{2}$ miles N.N.W. of Seefeld, consist of a bituminous schist or slate containing impressions of fish, which is quarried, not for building or roofing purposes, but solely for the extraction of bitumen.—The chief object of the present communication is to show that this schist does not belong either to the age of a tertiary deposit, or to that of the lias, to each of which epochs it has been referred by different authorities†. The inferior strata are much obscured by herbage and pine forests; but in ascending the western and northern flanks of the mountain, the out-crop of the schist is observable in ravines, and also in old quarries near

* Read before the Geological Society, April 3, 1829, and communicated by the Author.

† See Edin. Phil. Journal, vol. xiii. p. 372; and Annals of Philos., June 1821, p. 156.

near the abandoned oil-works, the sites of which are marked by heaps of the scorified fragments of the rock which have passed through the fire, and in some of which the black and shining scales of fish are still conspicuous. The schistose system appears to form a belt of about five or six hundred feet in thickness, the lower beds of which have been worked out; and the two furnaces now in activity are therefore established in the highest portions of it, and consequently at so great an elevation as to be near the limit of vegetation.—Here I found a Tyrolese and his sons heaping logs of wood upon a blazing pile, whilst the bitumen was exuding from a furnace below:—at the other furnace, the materials being still in preparation, I observed the following process. The stone quarried for use is distinguished by the workmen into two qualities· one, which is of black colour and of small specific gravity, affords a very viscid petroleum; the other is a brown slate, and gives off a thinner liquid*. Small fragments of the black and brown sorts being equally mixed together, are placed in fire-clay crucibles of a conical form, each about three feet in height, which at a few inches apart are luted upon an iron platform with holes, to which are attached pipes to convey the liquid bitumen into buckets. Large logs of pine are laid upon the crucibles, which are kept together by a loose low wall of stones in the form of a parallelogram. Fire is then applied, in three or four hours the bitumen begins to distil off, and in nine or ten hours it is completely extracted from the stone. The oil is then poured into strong barrels containing about fifty pounds each, and conveyed to Seefeld; from whence it is sent to considerable distances in the neighbourhood, being used as a medicine, and considered a powerful diaphoretic and specific for rheumatism †.

To return to the structure of this mountain.—The zone of schist on its western and northern sides is overlaid by and included in dolomite, some thick beds of which even alternate with the schist. The bituminous beds are in general very thinly foliated;—some of them so much so, as to resemble laminæ of lignite. All are extremely fetid when struck by the hammer, are very much contorted, and their general dip is to the S.S.E. at high angles, varying from 70° to 80°.

A much greater number of perfect impressions of fish were formerly found, when the lower beds were quarried, than in

* Some of these pieces are so bituminous, and especially the brown sort, that they do not leave more than one half their weight of earthy matter, after the melted bituminous portion has been allowed to run off.

† It is called "Stone oil" by the Tyrolese, and is sold at Seefeld for twelve florins per cwt.

the

the upper limits of the schist where the furnaces are now established. The few fragments however which I collected have enabled Mons. Valenciennes, the able coadjutor of Baron Cuvier in his new work on Fishes, to give the following account of them.

"There appear to be at least four species of fish among these specimens; of which three are particularly distinguished, by having quadrangular scales without articulating points, and ranged in sinuous and oblique rows, thus resembling the *Esox osseus* of Linnæus (*Lepisosteus* of Lacepède): but the fragments marked No. 1. and 2.* show that this species was of a form essentially different from the *Esox osseus*, in having a forked tail. The anal fin is placed behind and near the caudal, whilst a number of bony spines, at least eight in one of the specimens, appear in front of the articulated rays. The absence of vertebral fins prevents my deciding positively upon the order.

"In No. 3. the scales of the tail resemble those of the fossil fish of the *Küpfer schiefer* of Mansfeldt and Eisleben; with this distinction, that they do not advance so far into the tail fin.

"No. 4. differs from those above described in the larger size of its scales.

"No. 5. differs entirely from the three species described, in the form and much smaller size of the scales. The existence of dorsal, pectoral, and ventral fins, places this fish in the order *Abdominales*. The head and tail are wanting, but the scales of the belly form a toothed keel, and thus leave no doubt that it belongs to the genus *Clupea*."

In the form of their scales and in their general character, these fish of Seefeld have a strong resemblance to several of the genera and species found in the various deposits subordinate to the new red sandstone and magnesian limestone; whilst they differ altogether from the *Dapedium* of the lias, or any family of fish as yet discovered in, or above the oolitic series. These fish were the only animal remains I could detect in the formation, or in the accompanying range of dolomite, nor was there a trace of any fossil of the oolite or lias. There were however in the schist a few fossil vegetables; of which one specimen bears great resemblance to a *Lycopodium*, a family of plants which (as well as the fish) is characteristic of the formations *below* the new red sandstone.

In mineralogical characters the rock of Seefeld accords in many respects with that of Caithness, described by Professor

* These specimens are deposited in the Museum of the Geological Society, and were previously examined by Mons. Valenciennes during his recent visit to this country.

Sedgwick

Sedgwick and myself*, with which it further coincides in containing no animal remains, except fish; and as copper ore is extracted from this same chain of dolomite a few miles to the west, I am on that account still more inclined to refer this schistose deposit to some one of the formations between the new and old red sandstone, so remarkable for their abundance of Ichthyolites and their metalliferous character, among which the Thuringian copper slate, the magnesian limestone of England, and the Caithness schist, constitute prominent groups of different ages. Chemical analysis of the schist kindly undertaken by Mr. Faraday indicates, that it contains a much larger proportion of ammonia than has ever been obtained from any quality of coal, however bituminous; and although no positive conclusions can be drawn from this circumstance, still, when the vast number of the fossil fish is considered, a strong suspicion may be entertained that the destruction of such animal matter may have cooperated in the bituminization of the stone. The schist in its upper portion passes into a compact yellow dolomite which rises into rugged and barren peaks, the forests of pine wood terminating with the superior limit of the bituminous beds.—And here I cannot but express my dissent from that theory of Von Buch by which he attempts to account for the origin of all the dolomite of the Tyrol, of whatever age it may be. That eminent geologist imagines that these vast and lofty mountains acquired their dolomitic character by the magnesia derived from augitic rocks in a state of fusion. Now although in some localities which he cites, and where pyroxenic rocks are either in contact or contiguous with the dolomite, (as in the valleys of Fiemme and Fassa,) it may be allowed that secondary limestones have been altered into crystalline marble, and occasionally thrown up into fantastic forms; there is no possibility of a similar cause having produced the dolomite of Seefeld, where there is not a vestige of any igneous rock in the neighbourhood, but, on the contrary, where strong beds of the dolomite alternate regularly with the bituminous schist containing fossil fish. No geologist has ever sought to explain the presence of magnesia in the great deposits which are so highly charged with it in England and in Germany, by any theory like that of Von Buch; and if it be conceded that magnesia may have been an original ingredient in one formation, we may equally presume that it was an original ingredient of any other in which we now find it. For we know that the mountain limestone in England, the oolitic series

* In a memoir of the forthcoming Part of the Geological Transactions, now in the press; and read before the Geological Society, June 1828.

in

in the southern Tyrol, the green-sand in France, and the tertiary rock of Verona, are all occasionally distinguished by beds of dolomite, although the formations containing it are frequently far removed from igneous rocks, to the influence of which, any alteration of their original structure could by possibility be due. Nor can it be allowed that the grotesque peaks of the Tyrolese dolomite afford countenance to the above hypothesis; since their irregularity of outline may have been in great measure produced by the vast dislocations which these rocks have undergone subsequent to their deposition.—In another memoir I have endeavoured to show* that on the southern flank of the Tyrolese Alps near Bassano, where the secondary and overlying tertiary deposits have been elevated conformably, the serrated outline of those several formations from the newest tertiary conglomerates to the dolomite of the Jura limestone, is exclusively due to the high inclination and verticality of the constituent strata.

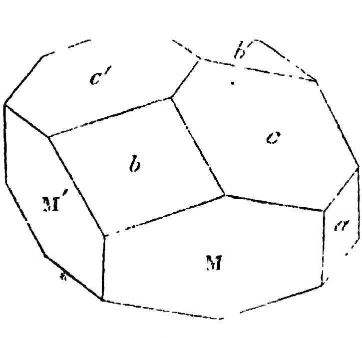
VII. *On the Crystalline Form of Bicarbonate of Ammonia. By Mr.* W. H. Miller.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

HAVING never seen any correct description of the crystals of bicarbonate of ammonia, and understanding that some attempts to crystallize it for the purpose of measuring the inclination of its faces were unsuccessful, I am induced to send you the following description and measurements, which, however, vary 15 or 20 minutes in different crystals.

It cleaves parallel to the lateral planes (M M′) of a right rhombic prism, which appears to be its primary form. The planes *b b*, are often wanting, and usually very small: when *a* and M are nearly equal, the crystals may easily be mistaken for regular six-sided prisms (see Henry's Chem. vol. i. p. 417, ed. 10.)



M on M′	=	111°	48′
c on *c*′	=	135	40
b on *b*′	=	117	40
a on M	=	124	7
a on *c*	=	112	10

* Phil. Mag. and Annals of Philosophy, June 1829; and read before the Geological Society, March 1829.

It

It may be observed that $\tan \frac{1}{2}(M \text{ on } M') = \frac{\tan \frac{1}{2}(c\,c')}{\tan \frac{1}{2}(b\,b')}$ ∴ the planes b and c are produced by the same kind of decrement.

The index of *ordinary* refraction for yellow rays is 1·558. I obtained the crystals by dissolving the common sesquicarbonate in water, in a strong well-corked bottle, at a temperature of about 130° Fahr., and permitting the solution to cool slowly.

Yours, &c. W. H. Miller.

VIII. *Analysis of British and Foreign Ships of War.* *By Mr.* Major, *formerly of the School of Naval Architecture**.

In exhibiting the following calculations to the notice of persons conversant with naval affairs few observations are required, with regard to their utility or importance; as the value of such tables is obvious, and their national importance will be readily acceded to. The facilities which the Honourable Navy Board granted me for the execution of an extensive plan of calculations, which I had the honour to submit for the benefit of the navy in October 1821, have been the means which have enabled me to compute the analyses here given. A description of this proposition may be found in the Annals of Philosophy for Nov. 1825. The particulars relative to the Ordnance and Victualling Office departments have been obtained directly from the respective establishments, and computed from official documents, in consequence of requests from the Navy Board for that purpose; those relating to accounts kept at the Navy Office, Dock-yards, and School of Naval Architecture at Portsmouth, are also derived immediately from these establishments, and are of the most authentic nature.

To Dr. Inman, the Professor of the Royal Naval College and School of Naval Architecture, it is due to me to say, that while at Portsmouth in 1822, in prosecution of the plan, the work was much promoted by him, and that he afforded me considerable facilities for effecting the object. I have also to acknowledge the liberality of J. Knowles, Esq. F.R.S., of the Navy Office, in giving me his advice and allowing me free access to many valuable and scarce works in his marine library.

As naval architecture has not been long cultivated in this country after the liberal manner of the sciences, by general and public investigation—without which no branch of knowledge is promoted with certainty,—complete calculations of all descriptions of ships are not to be expected: but it is hoped it will be allowed, that all that could have been looked for in this case has been done; especially when it is remembered that the consideration

* Communicated by the Author.

consideration of the forms, calculations, and equipments of ships, is not yet introduced in the official duties of the professional superintendents of His Majesty's Dock-yards. As opportunity may offer for completing them, numerous other calculations, and the details of those here presented, which are in my possession, will be added to the present.

The computations of ships here given, form but a small part of the digest of His Majesty's ships of war, proposed by me to the Navy Board in October 1821; as that work would require constant attention in calculating the elements of all sea-going ships at the Dock-yards. The present tables will, however, tend to reduce to precision and certainty, what is often unknown, as we may witness in looking at the extensive alterations which some of our English ships have required. In the Annals of Philosophy for November 1825, may be seen the view which I have taken of the best mode of pursuing the study of naval architecture: my plan is there explained at large. In the numbers for the following January and June may also be found additional remarks on a digest of the Navy.

It is to be regretted that the centres of gravity of some of His Majesty's ships have not been found by experiment, as it will be seen, by referring to the article on Ship-building in the Edinburgh Encyclopædia, that no objection to the mode, on the score of accuracy, now exists. Some writers have pretended to give the exact stability of ships without obtaining the centre of gravity of the entire vessel; but such pretensions are only vain and nugatory: at the same time the metacentric calculations here presented, as used in the French tables, are extremely serviceable as estimates of the stability of vessels.

The form of exhibiting the results of the calculations of British ships of war has been taken from the French Marine Ordinance of 1786, as a *general view* of the powers and capacities of the ships is well given by that description of table: for this purpose also, the averages of different estimates have been taken. The corresponding French tables, reduced to English measure, are also given for the purpose of comparison; as they contain the types from which our 84-gun ships and 46-gun frigates have been built,—two numerous classes, amounting together to fifty or sixty in number: the French *Franklin*, or English *Canopus*, having been the model of the one, and the *Hébé* frigate, the model of the other class. The elements of the Franklin will be found in the third column of the table of French ships of the line, as when captured she carried only eighty guns, four guns having been omitted at the ports of the admiral's cabin. The elements of our 46-gun class are those of the 18-pounder frigates in the French tables. For further guidance

guidance in the construction of ships, the elements of the ships of war designed by the celebrated Swedish constructor, Chapman, are given: they are extremely fine specimens of naval architectural skill. The French and Swedish tables, as here exhibited in English measure, have been calculated by Mr. Read and myself, jointly.

In a very absurd article on Ship-building, signed "Neptuni," in No. 6, of The Naval and Military Magazine, my plan of calculations is characterized, "as a mode of getting the light displacement (!), quite impracticable and totally erroneous." It is, however, evident that the miserable writers "Neptuni," or the *Sea Gods* (!), have never read my plan; or if they have read it, they have not been able to understand it, as they are obviously unacquainted with its nature, and are unequal to passing an opinion on it. They may now see that the work is not impossible.

In addition to the synoptical view of ships of war here given, other calculations on them, with the legitimate deductions arising therefrom, will in a short time be published.

Analytical Tables *of British Ships of War, according to the present Proportions and Establishments.*

TABLE I.

Principal Proportions, and Summary of the Weights which compose the Equipment of Ships of the Line.

Nature of the Elements.	1st Rate 120 Guns.		2nd Rate 84 Guns.		3rd Rate 74 Guns.	
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	
Length on the gun-deck	205	0	193	10	176	
Breadth extreme	53	6	51	6	47	
Depth in hold	23	2	22	6	21	
Load draught of water { aft			23	6	23	
Load draught of water { forward	24	3	22		21	
Light draught of water { aft	18	6	18		17	1[illegible]
Light draught of water { forward	15	6	14		13	[illegible]
Depth of keel and false keel, below rabbet in keel	2	6			2	[illegible]
Height of lower portsill, amidships, out of water	5	8	6	2	5	8
	Tons.		*Tons.*		*Tons.*	
Burthen in tons, by builders' common rule	2616		2270		1741	
Total weight of ship and equipment, when victualled and furnished for six months	4710		3555·45		3056·1	
Weight of hull, or light displacement	2420		1809		1603	
Tonnage, or burthen, including masts, yards, and furniture, being the difference of the light and load displacement	2290		1746·45		1453·1	
Difference of the displacements of ships of the same rate	250		174		153	

 Weight

TABLE I. (*continued.*)

Nature of the Elements.	1st Rate 120 Guns.	2nd Rate 84 Guns.	3rd Rate 74 Guns.
	Tons.	*Tons.*	*Tons.*
Weight requisite to sink the ship 1 in. when loaded	26·1	21·6	17·86
——— light ..	21·5	16·03	15·2
	N°. Prs	N°. Prs	N°. Prs
Number, and calibre of guns, on lower battery	32 32 guns	28 32 guns 2 68 carr.	28 32
——— on middle deck .	34 24	— —	— —
——— on upper deck	34 24 lon.	32 24	28 18
——— on quarter deck	6 12 10 32 carr.	6 12 10 32 carr.	4 12 10 32 carr.
——— on forecastle...	2 12 2 32 carr.	2 12 4 32 carr.	2 12 2 32 carr.
Number of men in time of war	900	700	600
	Feet.	*Feet.*	*Feet.*
Depth of centre of gravity of displacement below floatation	9·5	8·3	8·13
Distance of centre of gravity from the middle of load water line	2·95	2·9	2·5
$\int \frac{2}{3} y^3 x$, where $y =$ half breadth, and x the length in feet	2154827	1686782	1281907
$\int \frac{\frac{2}{3} y^3 x}{D}$ (where D = whole displacement in cubic feet) or the height of metacentre above centre of gravity of displacement ..	13·07	13·55	11·98
	Tons.	*Tons.*	*Tons.*
Weight of guns, carronades, carriages and slides	325·6	221·3	182·4
——— of shot, powder, and other ordnance stores, complete for foreign service	225·7	192·4	154·1
——— of rigging, blocks, hooks and thimbles.	65·2	66·1	61·8
——— of water for three months at least, or as much more as can be conveniently stowed, with tanks included...	398·1	307·2	263·2
——— of provisions for six months, including spirits and casks	263·3	205·3	175·9
——— of wood, coals, and candles	161·0	125·2	107·3
——— of cables, hawsers, and chain cables..	74·7	60·8	51·25
——— of boats	14·1	11·3	9·61
——— of ballast (iron)	392·9	260·0	207·29
——— of anchors	20·8	17·75	15·0
——— of sails.	13·2	13·3	9·25
——— of masts and yards.........	121·0	103·0	78·3
——— of boatswain's stores...............	48·0	33·0	29·1
——— of carpenter's stores	32·0	24·5	21·3
——— of men and effects..................	90·0	70·1	60·0
——— of spare gear	13·0	11·5	9·2
——— of galley	11·4	8·7	7·1
——— of officer's and purser's stores	20·0	15·0	11·0
Total weight of equipment	2290·0	1746·45	1453·1
Weight of hull	2420·0	1809·00	1603·0
Total weight of ship, equipment, &c. (as above)	4710·0	3555·45	3056·1

TABLE II.

Principal Proportions, and Summary of the Weights which compose the Equipment of Frigates, Sloops, and Brigs.

Nature of the Elements.	4th Rate 60 Guns.		5th Rate 46 Guns.		6th Rate 28 Guns.		Sloop. 18 Guns.		Brigs. 10 Guns.	
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Length on the lower deck (for frigates)	172	6	150	1	113	8	100	0	90	0
Breadth extreme	43	8	39	11	31	6	30	6	24	6
Depth in hold	14	6	12	9	8	9	12	9	11	0
Load draught of water, aft	20	10	19	0	15	8	14	4	11	5
Load draught of water, forward	19	6	17	3	15	4	11	6	10	10½
Light draught of water, aft	14	9	14	6	11	6	11	0	9	5
Light draught of water, forward	11	10	10	10	9	4	6	3	7	2
Depth of keel and false keel below rabbet in keel	2	0	1	$10\frac{2}{3}$	1	4½	1	2	1	1
Height of lower portsill, amidships, out of water	7	9	7	1	5	4	4	8½	4	1
	Tons.		*Tons.*		*Tons.*		*Tons.*		*Tons.*	
Burthen in tons by builders' common rule	1481		1063		500		385		235	
Total weight of ship and equipment when victualled and furnished for six months	2208·35		1523·45		800·9		480·7		284·98	
Weight of hull or light displacement	1065		780		389		225		138	
Tonnage or burthen, including masts, yards and furniture, being the difference of the light and load displacement	1143·35		743·45		411·9		255·7		146·98	
Difference of the displacements of ships of the same rate	105·0		78		50		34		23	
Weight requisite to sink the ship one inch when loaded	14·7		11·25		8·6		6·1		4·1	
——— light	12·01		9·45		7·3		3·9		2·8	
	No.	Prs.	No.	Prs.	No.	Prs.	No.	Prs.	No.	Prs.
Number and calibre of guns on the lower battery	30	24	28	18 guns	18	32 carr.	—	—	—	—
——— upper deck	2	24	—	—	—	—	16	32 carr.	8	18 carr.
	28	42 carr.	—	—	—	—	2	6 guns	2	6 guns
——— quarter deck	—	—	14	32 carr.	6	18 carr.	—	—	—	—
——— forecastle	—	—	2	9	2	6	—	—	—	—
			2	32	2	18				

TABLE II. concluded.

Number of men in time of war	450	300	145	125	75
Depth of centre of gravity of displacement below flotation	7·2	6·5	4·89	4·05	3·41
Distance of centre of gravity from middle of load water line	2·25	2·1	1·6	1·4	1·02
$\int \frac{2}{3} y^3 \dot{x}$, where = half breadth, and x = length in feet	966132	614880	218774	142861	76320
$\frac{\int \frac{2}{3} y^3 \dot{x}}{D}$ (where D = whole displacement in cubic feet) or, the height of meta-centre above centre of gravity of displacement	12·50	11·719	7·80	8·79	7·65
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Weight of guns, carronades, carriages, and slides	134·2	88·4	32·1	22·7	8·48
——— shot, powder, and other ordnance stores for foreign service	136·1	82·5	57·2	30	11·8
——— rigging, blocks, hooks, and thimbles	55·2	34·1	22·4	13·3	7·2
——— water for three months at least, or as much more as can be conveniently stowed, with tanks included	193·6	119·2	64·1	40·1	26·2
——— provisions for six months, including spirits and casks	131·65	87·9	43·0	36·5	22·5
——— wood, coals, and candles	80·5	62·6	28·2	16·3	11·1
——— cables, hawsers, and chain-cables	48·2	35·0	16·5	13·9	8·4
——— boats	8·5	6·2	3·7	2·3	1·5
——— ballast (iron)	161·3	110·0	70·0	30·0	20·0
——— anchors	12·5	9·95	4·25	3·5	2·7
——— sails	8·1	6·2	3·1	2·6	1·3
——— masts and yards	65·2	46·0	28·2	14·5	7·5
——— boatswain's stores	25·1	18·3	10·1	7·2	4·1
——— carpenter's stores	17·5	12·1	7·2	4·7	3·2
——— men and effects	45·0	30·0	14·5	12·5	7·5
——— spare gear	7·3	5·5	2·1	1·5	·9
——— galley	5·8	5·0	3·05	2·5	1·8
——— officer's and purser's stores	7·6	4·5	2·2	1·6	·8
Total weight of equipment	1143·35	743·45	4119·9	255·7	146·98
Weight of hull	1065·00	780·00	389·0	225·0	138·00
Total weight of ship and equipment, &c. (as above)	2208·35	1523·45	800·9	480·7	284·98

[To be continued.]

IX. *Notices respecting New Books.*

A Chemical Catechism, in which the Elements of Chemistry, with the recent discoveries in the Science, are clearly and fully explained. By Thomas John Graham, M.D. *Member of the Royal College of Surgeons in London, &c. &c.*

THE author of the present work may be cited in addition to one we have lately noticed, (in vol. v. p. 51,) as an example of the small quantity of knowledge which will suffice for the trade of book-making; and we shall, without further remark, proceed to develop the very simple and easy means which have been adopted by Dr. Graham for the completion of his purpose. With this intention we shall copy, making observations as we proceed, the whole of the chapter on Light, except the notes: this we prefer to others on account of its brevity, and because we apprehend that it exhibits a fair specimen of Dr. Graham's powers in the adaptation of means to ends. It is to be understood, that except the questions, and those portions of the answers, which we shall print in italics, the whole of this chapter has been copied, literally, and without the slightest acknowledgment, from the authors whom we shall name.

"*What is the nature of light?*

Different opinions are entertained on this subject. The philosopher, Huygens, considered it is a subtile fluid filling space and rendering bodies visible by the undulations into which it is thrown. Sir Isaac Newton, *on the contrary,* considered light as a *material* substance, consisting of small particles constantly separating from luminous bodies, moving in straight lines, and rendering bodies luminous by passing from them and entering the eye.—Dr. Thomson's System of Chemistry, vol. i. p. 12.

What is the space called through which light moves?

A medium: thus air and other gaseous substances are called rare; while water, and transparent liquids and solids are termed dense media.—Dr. Fyfe's Manual of Chemistry, p. 98; *gaseous* being substituted for *aëriform.*

Does a ray of light pass in the same direction through rare and dense media?

No: when it passes through the same medium or perpendicularly from one medium into another, it continues to move without changing its direction; but when it passes obliquely from one medium to another of a different density, it always bends a little from its old direction, and assumes a new one. It is then said to be refracted. When it passes into a denser medium, it is refracted towards the perpendicular; but when it passes into a rarer medium, it is refracted from the perpendicular.—Dr. Thomson's System, vol. i. p. 13; *into* being substituted for *to.*

What happens when light strikes a polished opaque body?

It is reflected, and at the same angle at which it falls on the polished object.—Dr. Fyfe's Manual, p. 93.

What is meant by certain bodies refracting doubly?

When a ray of light passes through a crystallized body, provided the

the primitive form of the crystal be neither a cube nor a regular octahedron, it is split into two distinct rays, one of which is refracted in the ordinary way, while the other suffers an extraordinary refraction. Hence when an object is viewed through such a crystal it appears double, and therefore such bodies are said to refract doubly.—Dr. Thomson's System, vol. i. p. 15.

Is light a simple body, that is, are the rays of light indivisible?

No: light is separable by a prism into seven primary rays or colours, as well as into others which appear to be distinguished by certain chemical powers. *For instance, if a ray of light in passing through a small hole, with a prism near it,* be made to fall on a sheet of white paper, a spectrum is produced, composed of seven distinct colours, viz. red, orange, yellow, green, blue, indigo, violet.—The first three lines from Dr. Paris's Medical Chemistry, p. 225; the lines in italics slightly altered from Dr. Fyfe's Manual, and the remainder from the same work, p. 95.

Is there any difference in the power of illumination in these rays?

They have very different illuminating powers. Thus, if a small object is placed at either end of the spectrum, it is seen indistinctly, but if brought towards the centre, it becomes much more distinct, the greatest illuminating power being between the bright yellow and the pale green.—Dr. Fyfe's Manual, p. 96.

What was Sir Isaac Newton's opinion with respect to the cause of the different colours of bodies?

That it is owing to their power of absorbing all the primitive colours, except the peculiar one which they reflect, and of which colour they therefore appear to our eye.

This is the only complete answer which we have hitherto met with, the author of which does not occur to us.

Is not solar light capable of producing great chemical changes?

Yes. A familiar instance of this is the blackening of indelible or marking ink, the traces of which are at first invisible, but soon become black on exposure to sunshine, or even the day light, from the decomposition of the salt of silver which it contains.—Fyfe's Manual, pp. 97 and 98.

Then the solar light is composed of three distinct rays: have the goodness to recapitulate them?

They are, 1st, the luminous rays affording light; 2nd, the calorific causing heat; and 3rd, the chemically acting ray.—Slightly altered from Fyfe's Manual, p. 98.

Are you aware of any marked effects which light has on the vegetable and animal creation?

I am sensible that the agency of light exerts a remarkable influence over both the vigour and colour of vegetables and animals. Plants, for instance, may be made to vegetate tolerably well in the dark, but then their colour is always white, they have scarcely any taste, and contain but a very small proportion of combustible matter. In a very short time, however, after their exposure to light, their colour becomes green, their taste is rendered much more intense, and the quantity of combustible matter is considerably augmented. *The colour*

lour of animals depends materially on the same agency, as is proved by the striking difference of colour existing between the animals of the frigid and torrid zone.—Dr. Thomson's System, vol. i. p. 20; *then* being substituted for *in that case.*

Have *not* certain bodies the property of absorbing the rays of light, of retaining them for some time, and of again evolving them unchanged, and unaccompanied by sensible heat?

Yes. Thus in an experiment of Du Fay, a diamond exposed to the sun and immediately covered with black wax, shone in the dark, on removing the wax, at the expiration of several months. Bodies gifted with this property are called solar phosphori. Such are Canton's, Baldwin's, and the Bolognian phosphori. To the same class belong several natural bodies, which retain light, and give it out unchanged. Thus the sea is occasionally when agitated, a natural solar phosphorus; putrid fish have a similar property, and the glow-worm belongs to the same class."

Now this question and answer are in the very perfection of peculation; except the slight transposition of a few words, required by an omission, the whole of both is taken from and forms a part of one paragraph of vol. i. p. 160, of Dr. Henry's Chemistry, beginning "Certain bodies have," &c. and after the words "sensible heat," omitting "yes." In the answer the same paragraph is continued.

This answer concludes the text of Dr. Graham's chapter on Light; and it will be observed that we have traced about five-sixths of the whole to the various authors from whom they have been literally taken. Such is the case with the text; and similar practices have been pursued with the notes of this chapter. In some instances indeed, but evidently that what has been pilfered may pass for his own, Dr. Graham has actually added the names of the authors to whom he is indebted; but the proportion is not great: for of the matter of the notes, 52 parts are pilfered, 32 borrowed, and 16 we will generously divide between the author and undiscovered sources.

After these displays of our author's acts of appropriation, the reader may perhaps doubt whether his volume really contains any one statement which Dr. Graham can fairly claim as his own. We have however, as we think, discovered some portions of the work, which if they be not original, we are quite sure the real authors will never claim; and these very remarkable exceptions to the Doctor's general method of proceeding occur under the head of Specific Gravity.

In page 7 of the Catechism we have the following question and answer:—

"*How do you ascertain the specific gravity of fluids?*

There are several methods by which it may be ascertained; but the best is performed by what is called a *gravity bottle*, which is a glass bottle with a slender neck, furnished with a ground conical stopper. A gravity bottle, called a "*thousand grain bottle,*" from its containing just a thousand grains of distilled water, is considered the best instrument for determining this point with great facility. The thousand grain bottle is sold together with a weight, which is an exact counterpoise for it, when filled with distilled water at 60° of Fahrenheit.

 This

This instrument consequently does not require the aid of any computation, but is simply filled with the fluid to be examined, and placed in one scale of the balance, while its counterpoise is placed in the other. If the contained fluid be lighter than water, it will appear deficient in weight, and as many grains must be added to the scale that contains it as may be sufficient to restore the balance. This shows at once that the specific gravity of the fluid in question is *negative*, or less than the standard (1000), and consequently that it must be expressed by a fractional number; but, should the fluid be heavier than water, the bottle will preponderate, and weights must be put in the opposite scale, when their amount being *positive*, must be added to that of the standard. For example, if the bottle were filled with sulphuric æther, it would require from its being lighter than distilled water 739 grains to be placed in the same scale to restore the balance, and consequently its specific gravity would be expressed thus, 0·739."

Now we will grant that this is the true specific gravity of the fluid in question: but Dr. Graham has committed the extraordinary blunder of deducting 739 from 1000, and finding that 739 remain, the real fact being that only 261 grains should be put into the scale with the bottle, which would indeed give 0·739 as the specific gravity of the fluid.

Dr. Graham then proceeds thus:—"Had it (the thousand grain bottle) been filled with sea-water, which is rather more dense than that which is distilled, twenty-six hundredths, or rather better than a quarter of a grain, must have been added in the opposite scale, and which, as already explained, must be added to the standard 1·000 to express the specific gravity of such water, which would be stated thus, 1·026."

We will again admit Dr. Graham's accuracy in stating the specific gravity of the fluid under consideration, but there must be some peculiarity in his edition of Cocker, for it would seem to show that by adding twenty-six *hundredths of a grain* to 1000 grains, they become one thousand and twenty-six grains. If this be one of "the recent discoveries in science" to which Dr. Graham alludes in his title page, it is not, we venture to pronounce, one of those which it is the boast of the author to have "clearly and fully explained."

Again; in illustrating the method of taking specific gravities,—an operation which we are sure Dr. Graham never performed,—he supposes that he takes a piece of gold, weighing 48 grains, which he further supposes to lose 6 grains by immersion in water; he then adds "we now divide the real weight of the body in air, viz. 48 grains, by this loss, 6 grains; which gives us 8 as the specific gravity of the body under examination." Now this is really something new, viz. that the specific gravity of gold is only 8; and what is truly astonishing, is, that Dr. Graham has so entirely forgotten to take advantage of his own discovery, that in p. 307 of the Catechism, we actually find him recurring to his usual practice, and stating the specific gravity of gold to be 19·30, which he learned from one of the authors whom he has laid so largely under contribution.

Dr.

Dr. Graham is nearly as great an adept in the art of puffing, as in the practices of spoliation, borrowing, and blundering: he has, it seems, published three other books; and in an advertisement prefixed to the Chemical Catechism we have the opinions of various critics respecting the works in question; in due time we expect to find the same persons giving similar judgments of the Chemical Catechism. We shall undoubtedly hear, to copy the phrases of Dr. Graham's reviewers,—and *his* they are we doubt not,—that the Catechism is a work "of a very superior order,"—"recommended by talent and experience,"—"incomparably superior to any similar work in our language,"—"a very valuable acquisition to the family library,"—"lays a large claim to a decisive superiority,"—"is altogether deserving of permanent popularity;" with many other strains equally laudatory and quite as true.

In concluding a notice extended much beyond the limits demanded by the nature of the work; we recommend Dr. Graham when he writes again, if he should wish to avoid detection and exposure, to take a hint from Sir Fretful Plagiary, and serve his pilferings "as gipsies do stolen children,—disfigure them to make them pass for their own."

X. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

April 30.—A PAPER was read, entitled "On the respiration of birds;" by Messrs. W. Allen and W. Hasledine Pepys, FF.R.S.

The inquiries of the authors on human respiration, and on that of the Guinea-pig, of which they communicated the details to the Royal Society in former papers, are here extended to the respiration of birds. Pigeons were the subjects of these experiments, and the same apparatus was employed as the one used for the Guinea-pig, described in the Philosophical Transactions for 1809.

The object of the first experiment was to ascertain the changes which take place in atmospheric air when breathed by a bird in the most natural manner. For this purpose a pigeon was placed in a glass vessel, containing about 62 cubic inches of air, and communicating with two gasometers, one of which supplied from time to time fresh quantities of air, and the other received portions which became vitiated by respiration. The experiment lasted 69 minutes, and was productive of no injury to the bird except a slight appearance of uneasiness whenever the supply of air was not sufficiently rapid. On examining the air at the end of the experiment, no alteration had taken place either in the total volume of air or the proportion of azote which it contained; the only perceptible change being the substitution of a certain quantity of carbonic acid for an equal volume of oxygen gas, amounting to about half a cubic inch per minute, and being equivalent to the addition of 96 grains of carbon in twenty-four hours.

Two experiments were made on the respiration of oxygen gas, obtained from chlorate of potash, and containing in the one case two, and in the other only one, per cent of azote. Under these

circumstances, it was found that the volume of the gas was unaltered, and that a similar quantity of oxygen gas had been abstracted, but that a much smaller quantity of carbonic acid had been formed than in the last experiment; the remaining portion being made up by azotic gas which had been given out from the lungs of the bird, and the volume of which was just equal to that of the oxygen absorbed. The bird was somewhat disturbed during the experiment, but recovered immediately and perfectly on being released from its confinement.

In the fourth experiment, in which a pigeon was made to respire a mixture of oxygen and hydrogen with a small proportion of azote (the oxygen being in the same proportion as in common air), it was found that there was no loss of oxygen; but that a quantity of hydrogen disappeared, and was replaced by an equal volume of azote. The authors observe, that birds have a quicker circulation of blood than other animals; and also, that they are more sensible to the stimulating effects of oxygen.

May 7.—A paper was read, entitled "Experimental Examination of the Electric and Chemical Theories of Galvanism;" by William Ritchie, A.M. F.R.S.

After showing that the theory of galvanism originally proposed by Volta, and generally termed the electric theory, is still the universally received doctrine among continental philosophers, the author adduces several experiments proving the fallacy of the principles on which that theory is founded. He points out the inconclusiveness of the reasoning by which it has been inferred, that dissimilar metals, by being simply placed in contact with one another, are instantly thrown into opposite electric states: for in all the experiments which have been made with a view of establishing this fundamental principle of the electric theory, the metals have been exposed to the oxidizing action of the air, which is a constant source of electric disturbance, and the operation of which has been strangely overlooked. The author found, by forming galvanic circles with two different metals and an interposed acid, that when he used different kinds of acid, or varied the degree of their dilution, the electro-magnetic effects, as measured by a delicate galvanometer, bear no sort of relation to the conducting power of the fluid, as is assumed in the voltaic hypothesis. He deduces the same conclusion from experiments made with an apparatus by which the fluid is confined in a rectangular box, divided by a membranous diaphragm into two compartments, so as to allow of the addition of an acid to the fluid contained in one of the compartments, and thereby limiting its action to one of the metallic surfaces. By means of another contrivance, the author ascertained, that of two different metals, the one which when acted upon by an acid combines with the greatest quantity of oxygen, as measured by the volume of hydrogen disengaged, is always positive with respect to the other metal. Even two pieces of the same metal, differing in hardness, will be acted upon by the same acid in different degrees, and may thus be brought into different states of electricity. In general it is the harder of the two pieces of metal which

which becomes positive; but with steel the reverse obtains. It would appear, however, that with the same pairs of metallic discs, the direction of the electric current is determined by the nature of the acid employed: thus nitrous acid, acting upon zinc, copper, or iron, gives rise to a current in a direction opposite to the current which is produced by the sulphuric, nitric, or muriatic acids. Variations in the temperature of the metals will also occasion diversities in the results, not hitherto satisfactorily explained on any theory. From one experiment the author is led to infer, that an acid is capable of combining with a pure metal, without the latter being previously reduced to the state of an oxide.

May 14.—A paper was read, entitled "On the Composition of the Chloride of Barium;" by Edward Turner, M.D. Professor of Chemistry in the University of London. Communicated by the Rev. Dr. Lardner, F.R.S.

The frequent employment of chloride of barium in delicate chemical investigations, renders an exact knowledge of its composition peculiarly desirable; and this has become a more important object of inquiry since it has been made by Dr. Thomson the basis of his calculation of the chemical equivalents of sulphuric acid, and of thirteen metals and their protoxides. He has deduced from his experiments with the chloride of barium, the number 36 as the equivalent of chlorine, 70 as that of barium, and 78 as that of baryta; whence the equivalent of the chloride of barium would be 106: and accordingly, on mixing this quantity of the chloride with 88 parts of sulphate of potash, each being previously dissolved in separate portions of distilled water, he finds a complete double decomposition has taken place; the resulting sulphate of baryta reduced to dryness, weighing 118 parts; and the muriate of potash yielding 76 parts of chloride of potassium. Hence he infers that 40 is the equivalent number for sulphuric acid, and 48 that for potash. Berzelius, however, maintained that this experiment, as well as the deductions from it, are not exact. Dr. Thomson having, in consequence of Berzelius's objections, repeated his experiments, still asserts their accuracy. The author of the present paper investigated the subject with the greatest care, employing materials in a state of perfect purity, and obtained results which coincided with those of Berzelius. He details the precautions he took for insuring the conditions of perfect purity in the substances with which his experiments were made, and to the neglect of which he traces some of the errors which he imputes to Dr. Thomson's analysis. But there exists also a more radical cause of error in the method employed by that chemist; for Dr. Turner finds, that when solutions of muriate of baryta and of sulphate of potash are mixed together, a small portion of the latter salt adheres tenaciously to the sulphate of baryta, which is precipitated, and thus escapes decomposition. By employing different processes, the author avoids this source of fallacy. First, from the chloride of barium, previously dissolved in water, he throws down sulphate of baryta by adding sulphuric acid; and secondly, he effects a precipitation from a similar

similar solution of the chloride by nitrate of silver, and infers the quantity of chloride from that of the fixed horn-silver obtained; having previously determined, by a separate series of experiments, the exact composition of horn-silver. The conclusion he draws from his researches is, that 100 parts of the chloride of barium correspond to 137·63 parts of the chloride of silver, which latter substance contains 34·016 parts of chlorine, and therefore leaves for the proportion of barium, 65·984 parts. The real equivalent of barium, however, will depend upon that of chlorine, which is itself not yet satisfactorily determined.

A paper was read, entitled "On the brain as an aggregation of parts;" by G. Spurzheim, M.D. Communicated by R. Chenevix, Esq., F.R.S.

The author contends that the human brain should be viewed not as a single organ, but as an aggregate of many different nervous apparatuses, each destined to the performance of a special function. What the peculiar function is which each of the cerebral organs performs, cannot, indeed, be at all inferred from its anatomical structure, but must be gathered from other evidence. In comparing the brains of different animals, this process must be reversed; and whenever we find organs performing the same function in different animals, we must conclude that they are in reality the same organs, however they may differ in their size, structure, appearance, or situation. The brains of animals belonging to the same class resemble each other in their general type, although the special apparatuses appropriated to each function may vary in their size and number.

The author next attempts to establish the proposition, that the parts of the healthy human brain are essentially the same, although somewhat modified in their size and quality, in different individuals. In support of this doctrine, he endeavours to show, that the several convolutions on the surface of the cerebrum may be identified in different brains; and that this identity may be recognized in the two lateral halves of the same brain. On examining the brains of some idiots, he found that certain convolutions, which he believes to be capable of being thus identified, are defective, and others entirely wanting. He makes a similar observation on the brain of an ourang-outang which exhibits a closer analogy to the human structure than that of any other mammiferous animal, and in which he could not discern some of the convolutions which exist in the brain of man. The paper was accompanied by drawings of the brain of an idiot, from a preparation in the possession of Mr. Stanley; and of that of an ourang-outang belonging to Dr. Leach, now deposited in the museum of the Royal College of Surgeons.

May 21. The President in the chair.—A paper was read, entitled "On the action of grooved surfaces on light;" by Dr. Brewster, LL.D., F.R.S., &c.

May 28.—A paper was read, "On the nerves of the face;" by Charles Bell, Esq.

June 4.—A paper was read, entitled, "On the geometrical representation of the powers of quantities which involve the square roots

roots of negative quantities;" by the Rev. John Warren. Another paper was also read, descriptive of a case of a tumour removed from the head by Sir Everard Home.

June 18.—A paper was read "On the conversion to a vacuum of the experiments with Captain Kater's pendulum;" by Captain Sabine, Sec. F.R.S.

The President in taking a sessional farewell of the Fellows, congratulated the Society upon its continued prosperity, and paid a just tribute to the memory of Wollaston, Young, and Davy, whose loss the Royal Society felt in a particular manner: but, said the President, whilst we lament their death, let us hope that their mantle will descend upon others.

GEOLOGICAL SOCIETY.

March 6.—S. P Pratt, Esq., of Lansdown Place West, Bath; and the Rev. Robert Everest, M.A., of Devereux-Court, Temple, were elected Fellows of this Society.

An account of a remarkable fossil-plant in the coal-formation of Yorkshire; by John Lindley, Esq., F.G.S., F.R S., &c., and Professor of Botany in the University of London, was read.

This plant was described as a fern, resembling, in most respects, the *Trichomanes reniforme*, a recent species found in New Zealand, but differing in the nature of its venation. It was said to exhibit distinct and unequivocal traces of the marginal fructification peculiar to the genus Trichomanes. After comparing it with the fossils comprehended by M. Adolphe Brongniart in his genus Cyclopteris, and showing that it was not referable to any known species of that group, the author concluded by assigning to it a specific character, and the name of *Trichomanes rotundatum*.

The reading of a paper "On the remains of Quadrupeds which have been discovered in the Marine and Freshwater Formations of the Peninsula of Italy;" by J. B. Pentland, Esq., was begun.

March 20.—R. W. Blencowe, Esq., M.A., of 10, Gloucester-Place; R. Otway Cave, Esq., M.P., of 30, Upper Grosvenor-street; Captain Samuel Edward Cook, R.N , of Newton, Northumberland; Robert Daubeny, Esq., of Cork street; George Lowe, Esq., of Highgate; and J. P. Fearon, Esq., of 1, Crown-Office-Row, Temple,—were elected Fellows of this Society.

A paper was read, "On the Tertiary and Secondary Rocks forming the Southern Flank of the Tyrolese Alps, near Bassano;" by Roderick Impey Murchison, Esq., Sec. G.S., F.R.S., &c.*

The tertiary, or sub-alpine rocks which fringe the southern extremity of the Tyrolese Alps, between the rivers Brenta and Piave, may be said to divide themselves into two great natural groups of very different ages.

1st.—An outer, or younger zone composed of conglomerates with subordinate beds of yellow sand and blue marl containing shells, which, from a limited number collected by the author, seem to be

* Mr. Murchison's paper will be found in our last number, at p. 401.—Edit.

identical

identical with those which in other parts of Italy, at Nice, &c. characterize the newer tertiary formations (Sub-Apennine).

2d.—An inferior system of yellow and green calcareous sandstone, blue marl, and compact limestone; the higher portions of which offer a few shells analogous to those of the Bourdeaux basin; while the lowest beds are distinguished by a vast variety of organic remains, more than one half of which seem to be identical with the species found in the Calcaire grossier and London clay.

A nummulite limestone forms the base of the above series, and is shown to be conformable to the scaglia, or rock containing ammonites, belemnites, and flints (the equivalent of the chalk), which rising into the Alps, passes into a dolomitic limestone charged with casts of fossils of the oolitic series. No rocks of igneous origin interfere, in this district, with the above order of superposition; but they are largely developed to the west of the Brenta, where they cut through the regular deposits. In illustration of the above, two transverse sections from S. to N. are then detailed.

1st.—From Asolo to Possagno, exhibiting the youngest group or conglomerate rising to the height of from 700 to 800 feet above the Adriatic, and dipping S.S.E. at angles increasing from 25° to 40°.

The dip and direction are the same in the succeeding strata of marl and limestone, for the space of five miles, and near Possagno they range conformably to the scaglia; with which, however, the lowest members of the tertiary series are there not seen in contact, owing to a denudation in the Val d'Urgana.

2d.—From Bassano to Campese in the Canal di Brenta. This section, owing to the much higher inclination of the beds, exhibits all the above members of the tertiary and secondary series in the short space of two miles. At Sarzon the marls of the Calcaire grossier inclined at 70° to 80°, are succeeded by a compact nummulite limestone, absolutely vertical; forming piers on each bank of the Brenta. This vertical nummulite rock is in positive and conformable contact with the scaglia, or ammonite rock, and they rise together to peaks of considerable height. The scaglia passes conformably into a dolomitic limestone, with remains of the oolitic series which forms the principal mass of this and the higher regions of the neighbouring Alps.

From the preceding facts, the author infers that some of the last expansive forces by which the secondary strata of the Tyrolese Alps have been set on edge, have also raised the tertiary deposits into their present vertical positions. Such forces, he presumes, found their issue in the adjoining basaltic and trap-rocks west of the Brenta. He next points to the above sections, as proofs that unconformability is not an invariable test of the distinction (if any such there be) between secondary and tertiary formations; and in describing the entire absence of the plastic clay in this district, he further remarks that it would be in vain to seek here for those various subdivisions of the tertiary series which exist in certain parts of Europe, and which some geologists would desire to establish as general types of these formations.

April 3.—J. S. Upton, Esq., M.A., of Trinity College, Cambridge; Edward Wynn Pendarves, Esq., M.P., of Pendarves, Cornwall, and of 39, Gros-

39, Grosvenor-street; the Rev. John Lodge, M.A., Fellow of Magdalen College, Cambridge, and principal Librarian of the University of Cambridge; the Rev. John Brown, M.A., Fellow of Trinity College, Cambridge; Captain John Franklin, R.N., F.R.S., &c. Commander of the late Expeditions overland to the N.W. coast of America, of Devonshire-street, Portland Place; and W. A. Cadell, Esq., F.R.S. L. & E. of Edinburgh,—were elected Fellows of this Society.

A letter dated March 14, 1829, from Dr. Prout to Professor Buckland, was read, stating that since the last meeting he had made an analysis of the bezoar stones from Lyme Regis and Westbury on Severn, and found the composition of all of them to be very similar, viz.: phosphate of lime and carbonate of lime, together with minute variable proportions of iron, sulphur, and carbonaceous matter. The relative proportions of the principal ingredients appear to differ somewhat in different specimens, and even in different parts of the same specimen: hence no formal analysis has been attempted; but the phosphate of lime may perhaps be estimated to constitute from about one-half to three-fourths of the whole mass.

Dr. Prout conceives this composition to prove that the basis of these bezoar stones is bone; and that Professor Buckland's opinion that they are of fæcal origin, or of the nature of Album Græcum, offers a very satisfactory explanation of their occurrence, and accounts at once for their chemical composition, their external form, and their mechanical structure.

A paper "On the Bituminous Schist and Fossil Fish of Seefeld in the Tyrol," by Roderick Impey Murchison, Esq. Sec. G.S., F.R.S., &c., was read *.

The bituminous schist of Seefeld is subordinate to a vast formation of dolomite, forming a lofty mountain chain which separates the Tyrol from Bavaria, in which it occupies a thickness of several hundred feet. This slaty rock is quarried solely for the bitumen it contains, which is extracted by subjecting the schist, when broken up and placed in crucibles, to an intense heat during ten or twelve hours. The only animal remains observed were fossil fish; and amongst these M. Valenciennes has discovered at least four species, three of which are distinguished by quadrangular scales without articulating points, thus resembling the Esox osseus (*Lepisosteus* Lacépède), but differing essentially from that genus in having a forked tail, as also in the position and structure of the fins; whilst another specimen is distinctly referred by him to the genus Clupea. With these ichthyolites were found a few vegetables, one of which has some resemblance to a Lycopodium.

As the general characters of the fish approach to those of the Kupfer Schiefer of Germany, of the magnesian limestone of England, and of the Caithness schist in Scotland, while on the other hand they differ entirely from all the species hitherto observed in the lias and oolitic series, the author, combining this fact with the mineral characters of the Seefeld rock and those of the metalliferous dolomite to which it is subordinate, refers the deposit to one of those formations below the new-red-sandstone so universally abundant in ichthyolites.

* This paper will be found in our present number, at p. 36.—Edit.

He further speculates on the probability of the destruction of so many fish having materially cooperated in the bituminization of the schist, because this rock, on distillation, gives off a much larger proportion of ammonia than has ever been detected in any coal, however bituminous. Lastly, the author dissents entirely from the theory of Von Buch that the dolomitic mountains of the Alps have derived their magnesia from augite rocks in fusion, and their peaked forms from simultaneous alteration of their structure:

1st.—Because no trap or augite rocks occur in this region.

2d.—Because fossil fish and plants in bituminous schist alternate with beds of the dolomite, which must therefore have been of contemporaneous origin.

3d.—Because the peaked outline of these mountains is sufficiently explained by the high inclination, vast dislocations, and numberless contortions, of the strata.

The reading of a paper, "On the tertiary deposits of the Cantal, and their relation to the Primary and Volcanic Rocks;" by C. Lyell, Esq., For. Sec. G.S., F.R.S., &c.; and Roderick Impey Murchison, Esq., Sec. G.S., F.R.S., &c., was begun.

May 1.—Samuel Cartwright, Esq., of 32 Old Burlington Street, and John Hall, Esq., of Edinburgh, were elected Fellows of this Society.

The reading of a paper "On the tertiary deposits of the Cantal, and their relation to the primary and volcanic rocks;" by Charles Lyell, Esq., For. Sec. G.S., F.R.S., &c., and R. I. Murchison, Esq., Sec. G.S., F.R.S., &c. begun at the last meeting, was concluded.

The authors have selected this district for description, because, although the adjoining fresh-water formations of the Limagne d'Auvergne, and of Puy en Velay, have been largely written upon; yet this of the Cantal has scarcely been noticed by any geologists, except in a cursory manner by Mr. Scrope, and formerly by M. Brongniart in his general observations on fresh-water deposits. (*Annales du Museum*, tom. xv. 1810.)

The fresh-water formations of Aurillac, or the Cantal, is not a continuous portion of the great lacustrine deposits of the Limagne d'Auvergne, from which it is distinctly separated, being bounded on the north, west and south, by gneiss and mica schist, and on the east chiefly by granite. The vast volcanic eruption of the Plomb du Cantal, the highest point of which is 5571 French feet above the sea, burst out within the area of this ancient and elevated lacustrine deposit long after the consolidation of its strata, which have in consequence been fissured in every direction from that great centre, and covered both by igneous and aqueous dejections; the limestone and marls being capped with sloping terraces of breccia and basalt, while the streams flowing from the central heights have widened the fissures into deep valleys. Two of the principal of these valleys, which radiate in a westerly direction from the Plomb, are occupied by the rivers Cer and Jourdanne, which unite near Aurillac, where the volcanic matter being about twenty-five miles from its point of eruption, has thinned out to a few irregular cappings, and consequently the lacustrine strata are there least obscured.

From

From an examination of numerous escarpments, the details of which are given in separate sections, the authors establish the following descending order.

1. Strong beds of white limestone, alternating with marls, and containing the following fossils:—Limneus longiscatus, and others; Planorbis rotundatus, and cornu; Ancylus elegans, &c.

2. White thinly foliated marls and marlstones, with a vast proportion of flinty and resinous silex, both in layers and in nodules, the latter frequently having the characters of the menilite of the Paris basin, containing innumerable Bulini, chiefly Bulini conicus and pygmæus, with Potamides Lamarckii, and a great quantity of stems of vegetables with gyrogonites. This middle system is distinguished by the paper-like lamination of its beds; and from the succession of matted vegetables and minute organic remains, it offers throughout many striking analogies to deposits in recent lakes. (Some of the thicker calcareo-siliceous beds are extensively worked for millstones.)

3. The base of these deposits is a brownish red plastic clay, charged with white quartz pebbles, &c., the detritus being apparently derived from the gneiss and mica schist, on which it rests.

The united thickness of the lacustrine formations of the Cantal is estimated at from 400 to 500 feet.

Several detached remnants of water deposits are mentioned as occurring between Aurillac and Mauriac; and although the authors conceive these may possibly have been formed in tarns (or small lakes), yet from the prodigious convulsions which the whole country has undergone posterior to the lacustrine deposits, it cannot be determined whether these might not have been bays of the great lake of the Cantal.

That a vast change in the relative levels of the various rocks of this region has taken place, is proved by many of the escarpments of the fresh-water marls being now at much greater heights than the border primary rocks on which they rest. The mineralogical appearances of the white limestone and marl are compared with the chalk of England, like which their surface is occasionally hollowed out into root-shaped cavities filled with alluvium; while some of these fresh-water flints are found strewed over the adjacent primary rocks, just as chalk flints are spread over the granite of Peterhead, Banffshire.

The valley of the Cer is then described. In ascending the deep gorges of this valley to the Plomb du Cantal, or centre of igneous eruption, the lacustrine strata gradually losing the horizontality which they exhibit at Aurillac, are found first much disturbed, then dislocated, isolated and altered, amidst trachytic breccia and basalt; and finally above Thiesac are entirely lost under the increasing mountainous accumulations of volcanic matter. *Siliceous fragments inclosing fresh-water shells are found at such very high levels in some of these ancient trachytic currents, and so much above any remnant of the fresh-water strata *in situ*, that the authors conceive they must have been ejected from below, and borne down from the central heights of the volcano, mingled with the detritus of volcanic rocks. In confirmation of what has been previously stated, that the great vol-

canic focus burst out within the area of the lacustrine deposits, it is stated that limestone and marls occur near Murat at the foot of the Eastern watershed of the highest ranges of the Cantal, where beds extensively quarried for lime, and containing several species of Limneus, Planorbis, Bulinus terebra, &c. with gyrogonites and plants, are overlaid by a prodigious accumulation of volcanic products. The fresh-water strata at this locality (La Vissiere) are unaltered in their character, but exhibit many faults.

The organic remains found in different parts of the Cantal, prove that this lacustrine formation, although geographically separated from, is geologically of the same age with that of the Limagne d'Auvergne, and corresponds as a whole to the different divisions of the fresh-water strata of Paris, and those of Hordwell Cliff and the Isle of Wight in England. It is more difficult to obtain an accurate knowledge of all the strata in the Cantal, than in the contiguous regions of Mont Dor, Clermont, &c. For in the last-mentioned districts, the volcanoes had issue amidst the primary rocks, their lava currents only reaching to the outskirts of the lacustrine formations; whereas those of the Cantal burst out in the very centre of these tertiary deposits, and either buried them or produced changes of the relative levels of the country, so as to occasion much abrasion of the original strata by the frequent shifting of the direction of the waters.

In conclusion, a comparison is instituted between the lower members of the lacustrine deposits of the Cantal, and those of the Limagne d'Auvergne and of the Puy en Velay.

A paper by Dr. Buckland was read, stating that he has ascertained that the bony rings of the suckers of cuttle-fish are frequently mixt with the scales of various fish, and the bones of fish, and of small Ichthyosauri in the bezoar-shaped fæces from the lias at Lyme Regis. These rings and scales have passed undigested through the intestines of the Ichthyosauri. Dr. Prout has also found that the black varieties of these bezoars owe their colour to matter of the same nature with the fossil ink bags in the lias; hence it appears that the Ichthyosauri fed largely upon the sepiæ of those ancient seas.

The author has also ascertained, by the assistance of Mr. Miller and Dr. Prout, that the small black rounded bodies of various shapes, and having a polished surface, which occur mixt with bones in the lowest strata of the lias on the banks of the Severn, near Bristol, are also of fæcal origin:—they appear to be co-extensive with this bone bed, and occur at many and distant localities. He has also received from Mr. Miller similar small black fæcal balls from a calcareous bed nearly at the bottom of the carboniferous limestone at Bristol; this bed abounds with teeth of sharks, and bones, and teeth and spines of other fishes: until they can be referred to their respective animals, the author proposes the name of Nigrum Græcum for all these black varieties of fossil fæces. They may have been derived from small reptiles or from fish, and in the case of the lias bone bed, from the molluscous inhabitants of fossil nautili and ammonites, and belemnites. In a collection at Lyme Regis there is a fossil fish from the lias, which has a ball of Nigrum Græcum within its body; for this the author proposes

poses the name of Ichthyo-copros. He also proposes to affix the name of Sauro-copros to the so-called bezoar stones of the lias at Lyme Regis, which are derived from the Ichthyosauri; and the name of Hyaino-copros to the Album Græcum of the fossil hyæna.

The form and mechanical structure of the balls of Sauro-copros, disposed in spiral folds round a central axis, are so similar to that of the supposed fir-cones or Iuli in the chalk and chalk marl, that the author has concluded that these so long misnamed Iuli are also of fæcal origin. On examination he finds many of them to contain the scales of fish; and Dr. Prout's analysis proves their substance to be digested bone. The spiral intestines of the modern shark and ray afford an analogy that may explain the origin of this spiral structure; and the abundance of the teeth of sharks and palates of rays in chalk renders it possible that the Iuli may have been derived from these animals. For these the provisional name of Copros iuloides is proposed. In the collection of Colonel Houlton, of Farley Castle, are several specimens of the Copros iuloides from the quarries of Maestricht.

The author has also recognized two other varieties of these fæcal substances in a collection of fossils brought from the fresh-water formations near Aix in Provence by Messrs. Murchison and Lyell.

The author concludes that he has established generally the curious fact, that, in formations of all ages, from the carboniferous limestone to the diluvium, the fæces of terrestrial and aquatic carnivorous animals have been preserved; and proposes to include them all under the generic name of Coprolite.

The examples he produces from the carboniferous limestone, the lias, the Hastings sandstone, the chalk marl and chalk, the Maestricht rock, the fresh-water deposits at Aix, and the diluvium, are taken respectively from the several great periods into which geological formations are divided.

May 15.—Wm. Babington, Esq., of St. John's Wood, Regent's Park; and Henry Humphry Goodhall, Esq., of the East India House, were elected Fellows of this Society.

The reading of a paper, "On the Hydrographical Basin of the Thames, with a view more especially to investigate the causes which have operated in the formation of the valleys of that river, and its tributary streams;" by the Rev. W. D. Conybeare, F.G.S., &c., &c. was begun.

June 5.—William Lonsdale, Esq., Lieut. 4th Reg. of Infantry, and late Honorary Curator of the Bath Philosophical Institution, &c., &c.; the Rev. Thos. Thorp, M.A., Fellow of Trinity College, Cambridge; the Right Rev. John Matthias Turner, D.D., Lord Bishop of Calcutta; David Douglas, Esq., F.L.S., of Turnham Green; Thos. Erskine Perry, Esq., B.A., of Trinity College, Cambridge, and 6 White Hall; and Charles Earl, Esq.,—were elected Fellows of this Society.

The reading of Mr. Conybeare's paper, On the Valley of the Thames, (begun at the last meeting,) was concluded.

The author has selected this river, not only as being the principal one of the island, but further as exhibiting valleys exclusively the result of

of denudation, and therefore better suited to illustrate that operation than valleys of more complicated origin, in the formation of which the elevation and dislocation of the strata have co-operated.

He first offers some introductory remarks on the opposite theories of the fluvialist and diluvialist, the former ascribing such denudations exclusively to the operation of the streams actually existing, or rather to the drainage of the atmospherical waters falling on the districts, which it is supposed have become thus deeply furrowed by the gradual erosion of these waters, continued through a long and indefinite series of ages; the latter contending that such a cause is totally inadequate to the solution of the phænomena, and maintaining that they afford evidence of having been produced by violent diluvial currents.

He proceeds to distinguish several different geological epochs, at which it is probable that currents must have taken place calculated to excavate and modify the existing surface. I. In the ocean, beneath which the strata were originally deposited. II. During the retreat of that ocean. III. At the periods of more violent disturbance, which are evidenced by the occurrence of fragmentarian rocks, the result of violent agitations in the waters of the then existing ocean propagated from the shocks attendant on the elevation and dislocation of the strata.—Four such periods are enumerated as having left distinct traces in the English strata. 1. That which has formed the pudding-stone of the old red-sandstone, ascribed to the elevation of the transition rocks. 2. That which has formed the conglomerates of the new red-sandstone, ascribed to the elevation of the carboniferous rocks. 3. That which has formed the gravel beds of the plastic clay. 4. That which has produced the superficial gravel, spread alike over the most recent and oldest rocks as a general covering, and which is found to contain bones of extinct mammalia: this (it is agreed) may be identified as the product of one æra, by the same evidence which is employed to demonstrate the unity of any other geological formation. Although diluvialists have usually directed their principal attention to the effects of the currents of this latest epoch of general disturbance, they by no means exclude the co-operation of any of the causes above enumerated.

In the body of his paper, the author considers the physical history of the Thames as divisible into the following sections. I. The collection of its head waters from the drainage of the Cotteswold uplands. II. The passage which it has forced across the Oxford chain of hills. III. That opened in like manner across the Chiltern hills to the London basin at Reading. IV. The re-entry of the river among those hills by the Henley defile. V. Its course through the plains of London to the sea.

I. The head-waters of the Thames are collected from the drainage of the Cotteswold uplands, over a tract about 50 miles in length, constituting the rivers Isis, Churn, Colne, Lech, Windrush, Evenlode, and Cherwell; this chain of hills being entirely broken through by the Colne, Evenlode, and Cherwell, which rise from sources in the Lias plains beyond its escarpment. The height of most of these sources is calculated at about 400 feet above the sea.

Each

Each of these valleys is separately described, and the general features of denudation presented by the Cotteswold chain are pointed out; these, it is asserted, bear traces of the most violent action, and they are contrasted with the state of repose which has evidently prevailed in the same districts from the period to which our earliest historical monuments ascend. In the most exposed situations, and those which appear to have suffered most from the action of the denuding causes, earth works of British and Roman antiquity are frequently found, attesting by their perfect preservation that the form of the surface has remained unaltered since the time of their construction. The drainage of the atmospherical waters has here produced no sensible effect for more than fifteen centuries: it is inferred, therefore, that to assign to this cause the excavation of the adjoining valleys, 600 or 700 feet deep, is to ascribe to it an agency for which we have no evidence; the evidence, indeed, as far as it can be examined, being adverse.

The disposition of the water-worn debris drifted against the Cotteswold chain and through the breaches opened in it, is also examined; much of it is shown to be derived from rocks situated to the north of the valley of the Warwickshire Avon, and completely cut off by that valley from the Cotteswold district. It is contended that pebbles of this origin can never have been transported by the actual streams, because the drainage of these streams is, and always must have been, from the escarpment of the Cotteswolds to the valley of Avon; whereas the course of the pebbles is directly opposite, viz. across the Avon, and thence to that escarpment and through its breaches. The valley of Shipston on Stour, which is described as a species of bay in the escarpment of the Cotteswolds, is stated to contain the most remarkable instance of this disposition.

II. The river collected from these head-waters flows through the plain of Oxford, which is covered to a great extent by water-worn debris; these are diffused over situations inaccessible to the present floods, and if produced by the actual streams, we must suppose that they have repeatedly changed their channel so as to have flowed successively over every portion of the plain where these debris are now found: the oldest historical monuments attest, however, the permanence of the actual channels, and the floods at present bring down no pebbles whatsoever.

On the south of the plain of Oxford the progress of the river is opposed by a chain of hills, called by the author the Oxford chain; this is passed by a defile broken through it. Were that defile closed, an extensive lake would be formed above Oxford, and the waters turned into the valley of the Ouse; by which they would empty themselves into the æstuary of the Wash.

The author inquires how this configuration of the valleys could have been produced on the fluvialist theory: he argues, that if the Oxford chain originally (as at present) formed a barrier of superior elevation to the tract intervening between itself and the Cotteswolds, that barrier must have turned all the drainage of the Cotteswolds into the vale of Ouse; under those circumstances the crest of the Oxford chain could never have been eroded by waters which would have flowed

flowed off in another direction. There is, however, another alternative; and the interval between these chains may be supposed to have formed originally a uniformly inclined plane, from the summits of the one to those of the other, along which the waters once flowed, and which they have since furrowed (by perpetually deepening their channels) into the present valleys. The author calculates the mass of materials which must on this supposition have been excavated and washed away, and contends that the drainage of atmospherical waters along such an inclined plane (which would have a fall of 10 feet per mile) does not afford an agent adequate to such vast operations.

The Oxford chain has suffered greatly from denudation, being broken into several detached groups.

Among these, some insulated summits are capped by patches of gravel, partly derived from transition rocks, partly from the chalk formation; these prove the extent to which denudation must have proceeded since they were lodged in their present situation, as they must have been transported from their native habitats along uniformly inclined planes, which have subsequently been excavated.

III. Issuing from the defile of the Oxford chain, the river flows through the plain of Abingdon and Dorchester, being joined by the Ock and the Thame. This plain, like that of Oxford, is deeply and extensively covered with water-worn debris. It is also similarly bounded by a lofty chain (like that of the Chilterns) on the south. An enormous breach is opened in this barrier for the passage of the river; all the same arguments apply in this case which were previously urged with regard to the passage of the Oxford chain.

The Chilterns, like most other chalky districts, abound with dry valleys, the rifted and absorbent structure of that rock not permitting the rain waters to collect into streams: these valleys agree in every other feature with those containing water courses, and have been obviously excavated by the same denuding causes, which, in this case, it is self-evident could not have been river waters. The surface of the chalk has been deeply and violently eroded, and is deeply covered with its own debris; this action appears, in part, to have taken place during the epoch of the plastic clay formation.

IV. The river having passed this defile, enters for the first time the London basin, near Reading; where it receives the Kennet, of which the course is shortly described. It rises in the chalk marl, beneath the chalk escarpment, a few miles beyond Marlborough; that escarpment being broken through in several places, to give passage to its head-waters. The author insists, again, on the contrast between the extensive denudations which must have occurred in this district and the permanence of its surface, as attested by the preservation of the numerous Druidical and other British monuments scattered over these downs.

A little below Reading, the Thames (first having received another small tributary, the Loddon) quits for a time the London basin, to re-enter, by a sudden bend, another deep defile among the chalk hills, ranging by Henley and Marlow to Maidenhead, when it finally enters the plains of London. It is difficult to account for this deflection

flection of the river, as a straighter course appears open to it by White Waltham to Bray: this line was surveyed for a canal by Mr. Brindley, and appears to be level to White Waltham, and thence to fall 47 feet to Mankey island, near Bray; so that a dam of a few feet across the river below Sunning at the mouth of the Loddon, would turn the waters into this channel. The author conceives the most natural mode of explaining this deflection of the river, is by the supposition that a higher range of tertiary strata once extended from the ridges of Bagshot-heath in this direction; forming a bar to the progress of the stream in this line.

V. The plains of London are covered with enormous accumulations of water-worn debris, chiefly of chalk-flints, and often abounding in fossil remains of elephants, hippopotami, &c.; the gravel is not confined to the low grounds, but caps the highest summits of the district; e. g. Highgate on the north, and Shooter's Hill on the south of the river. To explain this distribution of this gravel by the operation of the actual rivers, the author observes that it is necessary, first, to suppose that an uniform plane originally existed from the summit of Highgate to the Hertfordshire chalk downs, and from the top of Shooter's Hill to those of Kent; on the surface of which the rivers once flowed. 2ndly, That these rivers have subsequently washed away all that immense mass of materials which would be requisite thus to reconstruct the surface; and 3rdly, That having worn down that surface into nearly its present form, the rivers perpetually shifted their channels so as to distribute the gravel equally over the whole plain of London, yet remained long enough in each channel to lodge there deposits of this gravel 20 or 30 feet thick.

A paper was also read entitled, "A few facts and observations as to the power which running water exerts in removing heavy bodies," by Matthew Culley, Esq., F.G.S., &c., in a letter to Roderick Impey Murchison, Esq., Sec. G.S., F.R.S., &c.

The heavy rains which fell during three days of August, 1827, swelled to an unusual height the small rivulet called the College, which flows at a *moderate declivity* from the eastern watershed of the Cheviot hills, and caused that stream not only to transport enormous accumulations of several thousand tons weight of gravel and sand to the plain of the Till, but also to carry away a bridge then in progress of building, some of the arch-stones of which, weighing from $\frac{1}{2}$ to $\frac{3}{4}$ of a ton each, were propelled two miles down the rivulet.

On the same occasion, the current tore away from the abutment of a mill-dam a large block of greenstone-porphyry, weighing nearly two tons, and transported the same to the distance of a quarter of a mile. Instances are related to occur repeatedly, in which from one to three thousand tons of gravel are in like manner removed to great distances in one day; and the author asserts, that whenever 400 or 500 cart-loads of this gravel are taken away for the repair of roads, that one moderate flood replaces the amount of loss with the same quantity of rounded debris.

Parallel cases of the power of water are stated to occur in the Tweed, near Coldstream.

 ASTRO-

ASTRONOMICAL SOCIETY.

Feb. 13. (*Extract from the Report of the Council, presented at the Anniversary Meeting*).—The Society has to lament the loss, by death, of two only of its members during the past year. These are Captain Pringle Stokes, of the Royal Navy, who was engaged in surveying the coasts of South America; and Dr. William Hyde Wollaston.

To Dr. Wollaston every part of science seemed equally familiar; and of him it might perhaps be more truly said than of any philosopher who has preceded him, that "nil erat quod non tetigit, nil tetigit quod non ornavit." Astronomy was one of his chief and favourite pursuits—a taste inherited from his father, and cherished by his intimacy with the late Astronomer Royal of Dublin (now Bishop of Cloyne) and the present Astronomer Royal of Greenwich—an intimacy commenced in early youth at Cambridge, and maintained through life. Science is indebted to him for many ingenious and important speculations; such are his papers published in the Philosophical Transactions, on horizontal refractions, and on the horizontal refraction and dip of the horizon, containing his curious and ingenious invention of the dip-sector. Among the most remarkable of his astronomical papers, however, is that on the finite extent of the atmosphere, which affords a striking instance of the advantages that may accrue to science by the union of remote branches of knowledge in the same mind. The arguments brought forward in that paper in favour of the non-divisibility of matter *in infinitum*, from astronomical phænomena, carry with them at least every semblance of soundness, and afford a singular specimen of his acute and scrutinizing habit of thought; while the almost miraculous delicacy and curious felicity of his manipulation in the practical departments of science—that microscopic tact, which in a thousand instances led him, through routes impervious to grosser intellects, to the most striking, unexpected, and novel results—is there exemplified in a remarkable manner, in the minute and apparently insignificant apparatus with which he was enabled to verify his own views, under circumstances which would effectually baffle ordinary instruments and ordinary observers.

The sister science of optics is even more indebted to Dr. Wollaston than astronomy. His verification of the Huygenian law of double refraction; his investigation of the refractive and dispersive powers of bodies, as a separate branch of physical inquiry, on which the perfection of the achromatic telescope depends; his discovery of the dark lines in the spectrum, since independently observed, with more refined means, and in greater detail, by Fraunhofer; but chiefly as concerns our science, the ingenious and elegant method practised by him for perfecting the adjustment of the triple achromatic object-glass, give him the highest claims to eminence in this department. The instrument on which he tried and perfected this mode of adjustment is now, through his liberality, the property of this Society.

The Council think it right to include in this Report the letter containing his announcement of this valuable gift.

My

Dorset-street, Dec. 8, 1828.

My dear Sir,—Being in possession of a telescope which I hold in great estimation, and being desirous that its good qualities should be properly appreciated, and that it may become useful, I think I cannot do better than present it to the President and Council of the Astronomical Society of London.

I annex a memorandum of my wishes in regard to the destination of the telescope, as well as to what regards its origin. I have had it properly put in order by Dollond, and I now send it to you, as President of the Society, to be held at the disposal of the President and Council.

As I highly appreciate the honour of being a member of that Society, so I heartily wish them success in the very interesting and laudable object of their pursuits, and am, with sincere respect and regard, Most truly yours,

J. F. W. Herschel, Esq. V.P.R.S. W. H. Wollaston.
President of the Astronomical Society of London.

Memorandum alluded to in the foregoing letter.

This telescope is presented by Dr. Wollaston to the President and Council of the Astronomical Society of London, in hopes that they will not keep it useless, but lend it, or give it if they think proper, to any industrious and useful member of the Society, he not being at the time a member of the Council.

The telescope was made by Mr. Peter Dollond, in the year 1771, for the Rev. Francis Wollaston, F.R.S., who valued it very highly. Dr. Wollaston thinks that he has even improved it by screws added for the concentric adjustment of the object-glass, as described in the Phil. Trans. for 1822, p. 32.

The injunction contained in this letter, to render the instrument available for purposes of actual observation, has been complied with. It has been placed in the hands of Mr. Maclear, of Biggleswade, a member of the Society, for the purpose of enabling him to observe a series of occultations, computed by himself, of Aldebaran by the moon, and other similar phænomena.

Almost the last astronomical labour of Dr. Wollaston was a series of observations of a peculiar photometrical nature, for determining the relative brightness of the stars and of the sun. It has not yet been made public; but the results are such as to open new and more magnificent views of the constitution of the universe than even any which had preceded them.

Dr. Wollaston was born on the 6th of August, 1766, at East Dereham. He became a Tancred fellow of Caius College, Cambridge, shortly after taking his degree, and continued to reside there till 1789. He then removed to London for the improvement of his medical knowledge, and continued the practice of physic till the end of 1800, when an accession of fortune determined him to relinquish a profession he never liked, and devote himself wholly to science. It is from this period that we are to consider him as a public character in science. As a Commissioner of Longitude, he was ever

solicitous to promote whatever seemed likely to prove of practical utility, and render the longitude easy of measurement and calculation. Any well-grounded project for the improvement of chronometers was sure to find in him a firm supporter. The system of determining differences of longitude by sets of itinerant chronometers, as practised by Dr. Tiarks and Captains Foster and King, was warmly advocated and effectually supported by him.

Dr. Wollaston was many years a Vice-President of the Royal Society, and for a short time filled the chair of that illustrious body in 1820. He became a member of this Society in November 1828, under circumstances of which the irregularity could only be justified by the urgency of the case, and the impossibility of its being drawn into a precedent in future. Dr. Wollaston was proposed in the June meeting, and his certificate having hung till the following November, he ought, according to our rules, to have been balloted for at the ensuing meeting. The alarming situation of his health, and high probability of his dissolution previous to the December meeting, induced the Council at once to recommend to the meeting a departure from the established rule, and that the election should take place on the day already named; which was done, and received the unanimous sanction of the meeting, who insisted on dispensing with the formality of even a ballot. But the Council feel, that though such a case may justify the step, they must look to the general body of the members, now assembled on their anniversary, to ratify it, which they confidently expect will be done. His death took place shortly after; viz. on the 22d December 1828.

Officers for the ensuing year elected at this Meeting.

President: James South, Esq. F.R.S. L. & E. M.R.I.A. & F.L.S.—*Vice-Presidents:* Francis Baily, Esq. F.R.S. L.S. & G.S. & M.R.I.A.; Captain F. Beaufort, R.N. F.R.S.; Davies Gilbert, Esq. M.P. *Pres.* R.S. F.L.S. & G.S.; Olinthus G. Gregory, LL.D. *Prof. Math. Roy. Mil. Acad. Woolwich.*—*Treasurer:* Rev. William Pearson, LL.D. & F.R.S.—*Secretaries:* Rev. Richard Sheepshanks, M.A.; Lieutenant Wm. S. Stratford, R.N.—*Foreign Secretary:* Captain W. H. Smyth, R.N. F.R.S. & A.S.—*Council:* Right Hon. Lord Ashley, M.P.; Captain Everest, F.R.S.; Benjamin Gompertz, Esq. F.R.S.; J. F. W. Herschel, Esq. M.A. V.P.R.S. F.R.S.E. F.G.S. & M.R.I.A.; Rev. Dionysius Lardner, LL.D. F.R.S. & M.R.I.A.; John Lee, Esq. LL.D.; John William Lubbock, Esq. M.A.; Edward Riddle, Esq.; Edward Troughton, Esq. F.R.S. L. & E.; John Wrottesley, Esq. M.A.

March 13.—A paper was read, "On the errors likely to arise in the determination of the length of the pendulum, from a false position of the fixed axes." By Capt. Everest, Member of the Society.

A paper was then read from James Prinsep, Esq., assay-master of the mint at Benares, containing the observation of a solar eclipse on the 13th and 14th of April 1828, at Benares, with an account of the instrument, and the periods of the eclipse as obtained by construction. Mr. P. observed the transits of the limbs of the sun and of the cusps over the wire of an equatorial telescope.

The

The next paper read consisted of Observations made at the Calton Hill Observatory, Edinburgh, (lat. 55° 57′ 20″ N.; long. $12^m 44^s$ west of Greenwich):—1st, Of transits of the moon and moon-culminating stars, in 1828, by Mr. Thomas Henderson; 2d, Of occultations of stars by the moon, by Mr. John Adie. The longitude of Edinburgh west of Greenwich, computed by Mr. Henderson, from eleven corresponding observations of the first limb and three of the second limb, is $12^m 40^s{\cdot}55$.

A paper was also read, containing the places of Encke's comet, as reduced from thirty observations made by Mr. Dunlop, between October 26 and December 25, 1828, at Sir Thomas Brisbane's Observatory, Makerstoun, Roxburghshire.

There was, lastly, read a paper "On preserving the pivots of astronomical instruments;" by Lieutenant Peter Lecount, R.N. As the pivots of astronomical instruments are generally of steel, working in brass sockets, and are of necessity kept oiled, it would seem that when the oil becomes acid the galvanic arrangement is formed, and the steel pivot is decomposed and not the brass. Mr. L. therefore recommends that the pivots and sockets should be of the same metal, or, if this be inconvenient, that the pivots should be cleaned and fresh oil applied before acidity occurs, especially in the transit instrument.

April 10.—A paper was read, entitled "A catalogue of 195 double stars, taken from the *Histoire Céleste*, and reduced to Jan. 1, 1800;" by M. Berenger Labaume, of Marseilles.

A paper was also read, "On observing the eclipses of Jupiter's satellites at sea;" by Lieutenant Peter Lecount, R.N.

The next paper read contained astronomical observations made at the Observatory of the Imperial University of Wilna, by Professor Slawinski, in the year 1828.

These observations are of Jupiter, Mars, and Uranus, at opposition, and of Mars at quadrature.

Lastly, there was read a portion of a paper by Mr. Sheepshanks, to explain the method of interpolation given by Da Rocha, and employed by him in computing and correcting places of the moon in the Ephemerides of Coimbra, and on the further application of this method to astronomical computations.

FRIDAY-EVENING PROCEEDINGS AT THE ROYAL INSTITUTION OF GREAT BRITAIN.

May 1st.—The Lecture-room subject was on the audible properties of speech, and on the original pronunciation of the classical languages; particularly in reference to their long lost accent. The investigation was entered into by Mr. Smart, who reasoning upon the general nature of rhythm, emphasis, and accent in the various modern languages and also in the ancient ones, gave his opinion, supported by practical illustrations, of the manner in which the accent of the latter was originally determined.

Presents and illustrations of Eastern manufactures were upon the library table.

May

May 8th.—A complete and practical illustration of the nature and efficacy of the well known block machinery invented by Mr. Brunel, and erected at Portsmouth Dock Yard, was given by Mr. Faraday; the operations were all shown by means of the working models in possession of the Navy Board, which carried the process through upon a two sheaved block, four inches in length.

Some very large and peculiar crystals of sulphate of copper and carbonate of soda, presented to the laboratory, were placed with the presents in the library.

May 15.—A full and operative illustration of the principles and practice of wood-engraving was given by Mr. Mason It was illustrated by a numerous and well selected set of blocks, ancient and modern, foreign and English, and also by wood-cut impressions of all ages, sizes, style, and value.

Amongst other things in the library was a very complete set of the vegeto-alkalies, with other proximate vegetable principles; placed there by Mr. Morson.

May 22nd.—The evening's demonstrations related to the acoustical figures assumed by vibratory surfaces, and rendered evident by the superposition of heavy particles. It was given by Mr. Faraday for Mr. Wheatstone. Since the discovery of these forms by Chladni, they have rapidly risen into more and more importance, because of the sensible indications which they afford of those internal powers of solid matter which relate to cohesion, elasticity, &c.: the late researches by Savart show that they are a test far surpassing even polarized light in some respects, when applied to this species of investigation. Mr. Faraday's object was to commence with the earliest and simplest phænomena; to trace them, as Chladni the discoverer had traced them, to the more complicated effect; to connect them with the researches of Savart upon communicated and reciprocated vibrations, which were shown to be equally competent to produce these forms;—and then to give the general expression of the laws governing these phænomena. Upon the latter point some new matter was promised on a future occasion. The whole was illustrated by extensive series of diagrams and experiments.

A magnificent specimen of crystallized glass presented by Mr. Cookson was exhibited in the library.

May 29th.—The discourse this evening was rather literary than scientific, and was on the fictile vases of the ancients, by Mr. Singer the librarian. An extensive series of large and small vases was upon the table, and drawings of others placed up for illustration.

June 5th.—Dr. Clarke, who a few years since visited and ascended Mont Blanc, and made a considerable botanical and mineralogical collection in its neighbourhood, placed his collection upon the table, caused numerous drawings to be suspended for reference, and undertook to describe to his fellow-members the ascent and descent of Mont Blanc, and the natural history of the mountain. He had not time to complete more than half his object, and the communication will be resumed on a future evening.

June 12th.—On this evening Mr. Faraday gave an account of the

experi-

experiments made at the Royal Institution on the manufacture of glass for optical purposes. The investigation was taken up in consequence of the formation of a committee by the Royal Society, and a working sub-committee consisting of Mr. Herschel, Mr. Dollond, and Mr. Faraday. The late researches of the committee have been directed towards the manufacture of a very heavy and fusible glass, which from its optical properties offered some important advantages over flint glass; whilst its chemical properties were such as to admit of a process being applied to it that should produce perfectly uniform and homogeneous plates. The general process adopted was described; and it was stated, that three telescopes had been manufactured with the plates produced, which gave very good results and strong promise of ultimate success: the experiments, however, are still incomplete, but it is supposed a few months will finish them, when a full account will be laid before the parent committee of the Royal Society, and then published.

Some fine specimens of New-Forest oak timber, which had been experimented upon for the purpose of ascertaining their strength, were laid on the library tables, with the description and results of the experiments: also numerous mechanical models.

This evening concluded the meetings at the Royal Institution for this season.

XI. *Intelligence and Miscellaneous Articles.*

ORIGIN OF CERTAIN BRINE-SPRINGS IN NORTH AMERICA.—FORMER EXISTENCE OF ROCK-SALT IN THE "SALIFEROUS ROCK" OF THAT COUNTRY.—STRONG EVIDENCE THAT A HIGH TEMPERATURE WAS CONCERNED IN THE FORMATION OF THE NEW-RED-SANDSTONE.

As Dr. Bigsby, in his interesting sketch of the geology of Lake Ontario (Phil. Mag. and Annals, for May, p. 341), has mentioned Prof. Eaton's hypothesis, that the brine of the salt-springs in the district adjoining the Erie canal "is produced from elementary materials [the elements of common salt] contained in this [the saliferous] and higher rocks," it may not be useless to show that Mr. Eaton has adduced no real evidence to this effect, and that his account of the geological relations of these springs, in conjunction with Mr. Chilton's analyses of them, alluded to in the paper mentioned in the following notice sufficiently explains their origin. Prof. Eaton first made public his ideas on the subject in Silliman's Journal, vol. vi. p. 242. A specimen of the rock called water-limestone (a limestone subordinate to one of the members of the saliferous series) which forms the roof of the springs, if pulverized and examined ever so minutely, "presents nothing to the senses," he says, "resembling common salt." But "on exposing a fresh fracture of a specimen from this rock, for two or three weeks in a damp cellar, it shoots out crystals of common salt, sufficient to cover its whole surface." From these facts Prof. Eaton

Eaton deduces the theory just stated; repeating it in the Geological Survey, as cited by Dr. Bigsby. But surely the foregoing are insufficient data for such a theory. The water-limestone is doubtless intimately pervaded with chloride of sodium, which the moisture of the atmosphere, acting upon an exposed specimen, and the water of the springs, acting upon the rock *in situ*, extracts and dissolves. Adopting this view of the subject, we should expect to discover in the brines a portion of carbonate of lime, derived from the limestone; and accordingly Mr. Chilton found that earthy salt, sometimes in considerable quantity, in the brine of all the springs he analysed; and Dr. Beck also found it in his analysis of the brine of Salina. The brines of the Cheshire and Droitwich springs in England, on the contrary, which arise from the direct solution of rock-salt, to which no carbonate of lime is immediately contiguous, are either entirely free from it, or contain only a very minute proportion.

In Silliman's Journal, vol. xv. No. 2., for Jan. 1829, in a paper on "gases, acids, and salts, of recent origin and now forming, on and near the Erie canal," Mr. Eaton has again alluded to this subject, and has mentioned a curious fact, which, as far as the reading in Geology of the present writer has extended, has not hitherto been noticed in the saliferous beds of any other part of the world. This is the occurrence, in many localities, sometimes in the "calcareous slate" and marle-slate of the "saliferous rock," and sometimes in the superincumbent "lias*," of *innumerable moulds or cavities which have been formed upon crystals of chloride of sodium*; as well upon cubic crystals as upon the hollow inverted pyramidal aggregates of cubes, termed, by salt-manufacturers, *hoppers*. Many of these cavities also present every intermediate combination, from the mere *hopper*, to the solid and complete crystal. "That the rock was deposited while in a soft state," Prof. Eaton remarks, "upon the solid crystals, and the salt was afterwards dissolved, leaving the space it occupied empty, seems not to admit of a doubt." "But what changes," he continues, "have taken place which should produce solid crystals at one time, and dissolve them at another?"

Now there appears to be no difficulty in explaining all this; indeed the phænomenon, interesting as it is, explains itself. The crystals of chloride of sodium formerly existing in the strata, were doubtless deposited, at the æra of the formation of the saliferous rock, by the same agency, which, in other parts of the world, produced beds of rock-salt; and the salt has *simply been dissolved out* at a subsequent period, by the percolation of water through the superincumbent strata, leaving impressed in the rock cavities bearing the forms of the crystals. And such, without doubt, has been one source of the brine-springs of this district†.

Perhaps

* So Mr. Eaton here denominates it, but this stratum, as appears on comparing his former with his present statement, is evidently the limestone, subordinate to the saliferous rock, already mentioned.

† In Townson's Hungary, (as quoted in Kidd's Geological Essay, p. 117,) it is stated, that the lowest bed of marl in the great salt mines of Wielicza

Perhaps the form in which the salt has formerly existed in this case, as indicated by the cavities, may be regarded as throwing some light on the history of the new-red-sandstone. The presence of the *hoppers*, and especially their occurrence in greater numbers than the complete cubes, if we may be permitted to reason analogically from the artificial crystallization of salt by the evaporation of brine or of sea-water, indicates the existence of an elevated temperature, during the formation of the including strata and the deposition of their mineral contents. In the manufacture of salt in Cheshire, it is observed, that the *hoppers* are formed by the rapid evaporation of the saturated brine at a temperature of from 160° to 170°, Fahr.; and that the distinctness and perfection with which cubic crystals are produced, is in the inverse ratio of the temperature applied and the consequent rapidity of the evaporation; salt made at 130° or 140° first approaching to the distinct cubic form, and that made at 100° or 110° being in large and nearly cubical crystals*. The *hoppers*, indeed, appear to result, exclusively, from the evaporation of solutions of salt at a high temperature.

May not these facts, therefore, notwithstanding Dr. Holland (Trans. Geol. Soc. vol. i. p. 60.) has thought proper to exclude the agency of heat from the formation of the deposits of salt, be considered as corroborative of the opinion that the new-red-sandstone consists of the debris of the older rocks, which, partially in a state of minute division, and preserved, either wholly or in part, in a humid state, by the waters of a primæval ocean, have been as it were *torrefied* by the agency of heat acting from below? The peroxidated form of so large a proportion of the iron which it contains, and the evident injection from below at some distant period, in a state of igneous fluidity (or, to speak with caution, in a state similar to that of fresh-erupted lava) of the masses of porphyritic trap with which it is often intersected, are also circumstances which tend to strengthen this opinion.

Another fact observed in the manufacture of salt may perhaps be regarded as tending further to elucidate this subject. Although, as just remarked, the *hoppers* appear to result, exclusively, from the evaporation of solutions of salt at a high temperature, yet they are not formed when the brine is at the boiling point. At that heat, as may be observed in the process of making *stoved* or *lump-salt* in Cheshire, and in those by which salt is chiefly made in Scotland and at Lymington, small flaky crystals only are deposited, merely approaching in form to an irregular pyramid with a square base†. The occurrence of the *hoppers*, therefore, in the saliferous rock, indicates that the heat to which the solution that deposited the crystals was exposed,

is "mixed with salt in small patches and cubes." If water were to percolate slowly through this bed, the salt would be dissolved, and cubic and other cavities left in the marl, if of a texture sufficiently compact, which would then present a similar appearance to the beds described above.

* See Dr. Henry's paper in Phil. Trans. 1810, &c.

† See Dr. Holland's Report on the Agriculture of Cheshire, p. 53; and Dr. Henry, in Phil. Trans. 1810.

was insufficient to maintain the temperature of ebullition in that solution. And this is just what we might have expected to find, on account of the following circumstances. The heat, as the geological associations and history of the new-red-sandstone would appear to show, could have been but partially applied; the quantity of earthy matter mingled with the solution of salt must have interfered greatly with the free transmission of heat through the widely and unequally diffused immense heterogeneous *magma* formed by the whole; and the evaporation of the solution must at the same time have been in a great degree promoted and accelerated by the extensive surfaces presented by the earthy matter. The maintenance, therefore, or even the production, perhaps, of so high a temperature as 226°, which is the boiling point of saturated brine, until, at least, the whole or nearly the whole of the water had been evaporated, must be regarded, under all these circumstances, as a phænomenon which it is scarcely possible could have occurred; or if ever it did occur, it must have been transient in its duration, and very limited in its extent.

The abundant presence of the *hoppers*, therefore, in the American saliferous rock, evinces, on the one hand, that igneous action, (however remote its *focus*) must have been concerned in the consolidation of that rock; while, in conjunction with the presence of the cubical crystals, it shows, on the other hand, that the degree of heat to which it was exposed could not have been very elevated, prior at least to the evaporation of the water.

How long this heat continued, to what extent it became augmented after the evaporation of the water, and how far it may have been operative in giving the *beds* of *rock-salt*, such as those of Cheshire, their present form, agreeably to the views of Hutton and Playfair, are questions, involving the universal history of the new-red-sandstone formation; and constituting a subject of complicated inquiry, altogether distinct from that of the foregoing remarks. But it may not be irrelevant to observe, that if we adopt the theory which ascribes the formation of the beds of rock-salt to the igneous fusion of that substance, it will be necessary to inquire, whether the salt formerly existing in the cavities of the saliferous rock, has been merely dissolved out by water, as supposed above; or whether it has been melted out by heat, and diffused, when in a liquefied state, through the containing and contiguous rocks, from which the water of the brine-springs may subsequently have been impregnated. If the latter process has in reality taken place, the heat by which the salt was fused, would at the same time necessarily have indurated (as it were *baked*) the earthy matter in which the crystals had been deposited; a circumstance which must have tended materially to preserve the regular form of their impressions in the rock.

As the importance of instituting a new and extensive series of chemical researches on the contents of rock-salt from every locality, has been urged, in the paper on the existence of salts of potash in that substance*, it seems expedient to add a remark or two in this place, in reference to the utility of such an investigation in a geological point of

* See our last number, p. 415.—Edit.

view. To render it adequately available in the inquiry into the nature of the processes by which the deposits of salt were formed, it will be necessary to subject to analysis specimens of rock-salt from every bed that may exist in each deposit, and from every part of each bed, especially from wherever a variation may occur in the concretionary structure; together with specimens of all the intervening layers or veins of earthy matter, which must be subjected to as rigorous and as minute an examination as those of the salt itself. For the deposition of the various salts associated with chloride of sodium in sea-water and in rock-salt, takes place, with each of them, at a different stage of evaporation of the solution, and is dependent, in some degree, on the comparative proportion of the chloride which may remain in the fluid. If the beds of rock-salt, therefore, have been deposited from such a solution, the associated saline bodies will necessarily be found distributed, in each deposit, and in proportions respectively to the chloride of sodium, according to the varying circumstances of the evaporation by which they were produced. Further, if the salt has been subjected, subsequently, to igneous fusion, the situations in the mass and the comparative quantities of these associated substances, (and possibly also the state of combination of their elements,) will have undergone considerable changes, arising from the difference in specific gravity between them and the common salt, and the chemical action of so elevated a temperature; while the degree of influence attributable respectively to these circumstances, and their mode of action, can readily be estimated and allowed-for, by the Chemist, so as to afford the means of replying to the queries upon the subject, of the Geological Inquirer.

May 7, 1829. E. W. B.

EQUIVALENT FORMATION, IN ENGLAND, OF THE "SALIFEROUS ROCK" OF NORTH AMERICA.

The brine-springs of Salina, in the State of New York, which have been alluded-to in a paper "On the existence of salts of potash in brine-springs and in rock-salt," inserted in the last Number of the Phil. Mag. and Annals (vol. v. p. 411) arise in a formation, which has been termed, by Professor Eaton, in his Geological Survey of the district adjoining the Erie canal, "saliferous rock." This deposit, in common with all the muriatiferous formations of North America, as Dr. Bigsby informs us, excepting those of California, is remarkable for not containing rock-salt. In the Erie-canal district, it appears, ample opportunities for discovering it have been enjoyed; but nothing has been found, except cavities, dispersed through the strata, once evidently occupied by crystals of chloride of sodium, as described in the preceding notice.

The circumstance of its containing brine-springs and these cavities, appears to show that the saliferous rock is in reality the equivalent of the *new-red-sandstone*, as Prof. Eaton and Dr. Bigsby have represented; and not of the "*old-red-sandstone*, similar to that of Monmouth," as Mr. Featherstonhaugh, in a recent communication to the Geological Society (Phil. Mag. and Annals, N. S. vol. v.

 p. 139;

p. 139; or Proceedings of Geol. Soc. No. 9, p. 92.), has contended. It is probable that Mr. Featherstonhaugh has been led into this error by the contiguity to each other of the new- and old-red- sandstones in the county of Monmouth. This circumstance also seems to cast a doubt on Mr. F.'s opinion, as expressed in the same paper, that none of the beds which are in England higher in the series of formations than the coal-measures, are to be found in North America, north of 40° N. Lat. A minute comparison of the North-American rocks, as described, respectively, by Prof. Eaton, Dr. Bigsby, and Mr. Featherstonhaugh, would probably remove much of the obscurity in which this subject is at present enveloped. E. W. B.

May 7, 1829.

ON BOYLE'S FUMING LIQUOR, BY M. GAY LUSSAC.

This product, which is obtained by distilling a mixture of equal portions of lime and muriate of ammonia, and half a part of sulphur, appears to be well known as to its composition; but the circumstances under which it is formed require some consideration. M. Thenard states, that during its preparation no azote is evolved, that chloride of calcium and hyposulphate of lime are formed, and that it is the hydrogen of the muriatic acid of the sal-ammoniac which produces sulphuretted hydrogen with the sulphur; and M. Vauquelin could not obtain the fuming liquor when the sulphate or any other salt of ammonia was substituted for the muriate. Wishing to know from my own experiments what occurs during the preparation of this liquor, I began by repeating the experiments which had been made. I used oxyhydrous lime, and I have proved that not the smallest quantity of azote is produced during the formation of the fuming liquor. At first pure ammonia was disengaged, then hydrosulphuret of ammonia in white crystals, which eventually dissolved in the fuming liquor. The residue in the retort gave only chloride of calcium and sulphuret of lime and sulphate of lime, but not the slightest trace of hyposulphate or sulphate of lime; which will not appear surprising, when it is recollected that in this operation the heat is always raised to a low red, and that at this temperature the hyposulphates and sulphates are completely decomposed, and changed into sulphates and sulphurets. It is unquestionably the fact, that the ammonia does not supply the hydrogen of the sulphuretted hydrogen. It is possible, certainly, that the ammonia might have been decomposed, and an azoturet of calcium formed; but I have not been able to prove its formation.

The hydrogen might be derived from the muriatic acid, or from water, formed by the union of muriatic acid with lime; but it is much more natural to attribute it to the muriatic acid, because it can hardly be admitted that in the sphere of action of the same molecule, water is first formed, to be decomposed immediately afterwards. Nevertheless this fluid contributes to the production of sulphuretted hydrogen, as will presently appear.

When sulphate or phosphate of ammonia is substituted for the muriate, the fuming liquor is obtained, without any disengagement

of

of azote; and in this case it is evident that the hydrogen of the sulphuretted hydrogen is derived from the water. But to have a more direct proof of it, I prepared some sulphuret of calcium, to which I afterwards added some sulphur and water, and I subjected them to the action of heat: sulphuretted hydrogen was plentifullye volved. I obtained the same result by heating moistened sulphuret of barium without the addition of sulphur, or rather, by passing the vapour of water over the sulphuret heated to redness, because this sulphuret contains three proportions of sulphur; but with the sulphuret of calcium, which contains only one proportion, the addition of sulphur is requisite. Without this addition water is not decomposed; the assistance of double affinity is necessary.

It results from these observations, that during the preparation of Boyle's fuming liquor, a portion of the sulphuretted hydrogen is unquestionably produced by the hydrogen of the muriatic acid of the *muriate* of ammonia; but that the water formed at first by the combination of this latter acid with the lime, at a low temperature, may afterwards in part re-act upon the mixture of sulphur and sulphuret of calcium, and produce sulphate of lime and sulphuretted hydrogen. It follows also from these observations, that muriate of ammonia may be replaced by another ammoniacal salt, provided it is hydrated, or if it be not, that the action of water should be made to intervene.—*Annales de Chim. et de Phys.* March, 1829.

PURIFICATION OF OXIDE OF MANGANESE, BY M. LASSAIGNE.

Treat the native peroxide of manganese with diluted muriatic acid, in order to dissolve the foreign carbonates; then boil with it four or five times its weight of concentrated sulphuric acid, and evaporate the resulting mass to dryness; treat this with eight or ten times its weight of boiling water, and the protosulphate of manganese formed will be dissolved; but the solution contains iron and sometimes copper: the liquor is to be acidulated with sulphuric acid, if not already so, and then sulphuretted hydrogen passed into it throws down the copper in the state of sulphuret, which is to be separated by filtration. When all the copper has been thus separated, the liquor is to be boiled, to separate the excess of sulphuretted hydrogen; and then it is to be decomposed by carbonate of soda.

The yellowish-white precipitate, consisting of the carbonates of manganese and iron, is washed, and then treated hot with excess of solution of oxalic acid: oxalate of manganese results, which is precipitated in a fine white powder; and soluble oxalate of iron remains, which is separated by repeated washings with hot water.

The oxalate of manganese thus obtained, furnishes pure protoxide of manganese by calcination in close vessels, and the gaseous products are carbonic acid and oxide of carbon, in variable proportions. The protoxide of manganese, prepared in this way, is gray, and slightly greenish; it is totally soluble in muriatic acid without any disengagement of gas.—*Ibid.*

LIST OF NEW PATENTS.

To J. Lambert, esq., of Liverpool-street, London, for an improvement in making iron, applicable at the smelting of the ore and at various subsequent stages of the process up to the completion of the rods or bars, and for the improvement of the quality of inferior iron.—Dated the 30th of March 1829.—4 months allowed to enrol specification.

To W. Prior, of Albany Road, Camberwell, for improvements in the construction and combination of machinery for securing, supporting and striking the top-masts and top-gallant masts of ships. —11th of April.—6 months.

To J. Lihon, of Guernsey, but now residing at the Naval Club-House, Bond-street, a Commander in our royal navy, for an improved method of constructing ships' pintles for hanging the rudder. —14th of April.—6 months.

METEOROLOGICAL OBSERVATIONS FOR MAY 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·32 May 25. Wind N.E.—Min. 29·54 May 3. Wind S.W.
Range of the index 0·78.
Mean barometrical pressure for the month .... 29·996
Spaces described by the rising and falling of the mercury............ 3·050
Greatest variation in 24 hours 0·430.—Number of changes 23.
Therm. Max. 73° May 21. Wind N.E.—Min. 44° May 4. Wind S.W.
Range 29°.—Mean temp. of exter. air 57°·00 For 31 days with ☉ in ♉ 53·39
Max. var. in 24 hours 26°·00—Mean temp. of spring-water at 8 A.M. 50°·64

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere in the evening of the 2nd ... 82°
Greatest dryness of the atmosphere in the afternoon of the 28th 36
Range of the index 46
Mean at 2 P.M. 49°·7—Mean at 8 A.M. 56°6.—Mean at 8 P.M. 59·2
—— of three observations each day at 8, 2, and 8 o'clock......... 55·2
Evaporation for the month 5·05 inch.
Rain in the pluviameter near the ground 0·295 inch.
Prevailing wind, N.E.

Summary of the Weather.

A clear sky, 6; fine, with various modifications of clouds, 18; an overcast sky without rain, 5; foggy, 1; rain, 1.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
22	10	25	0	21	10	7

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
2	10	2½	3	1½	5	5	2	31

General Observations.—The general character of this month has been fine and very dry, for the whole quantity of rain does not amount to one-third of an inch in depth, and the amount of evaporation is comparatively great. The two or three hoar frosts at the beginning were not found so injurious as the heavy blight that accompanied the N.E. gale at the end of the month: but

but upon the whole, more genial weather for the formation and rapid growth of the fruits and vegetation in general, which have still a promising appearance, has not occurred since May 1822. The grasses generally, which looked so well at the beginning of the month, shot up suddenly, and were in seed too prematurely from the want of moisture; consequently the hay, the making of which has partially commenced in this neighbourhood, will not perhaps amount to an average crop.

Two parhelia appeared from 4 till 6 P.M. on the 4th instant; their colours were peculiarly bright, and each exhibited a white train from the sun about 15 degrees long, which terminated evanescently: they appeared to be formed in an almost imperceptible vapour that preceded the coming up of clouds from the S.W. Two other parhelia of a similar appearance, and distant from each other 45½ degrees, were observed from 4 P.M. till sunset on the 20th.

In the evening of the 14th a large lunar halo appeared, whose vaporous edge was full three degrees broad, and tolerably well defined for nearly an hour, when it began to wane. Several flashes of lightning emanated from the clouds in the northern horizon in the evening of the 15th, after a warm sunny day: and an unusually thick fog came on at 5 P.M. on the 16th, and continued throughout the night with a strong gaseous smell.

On the 24th a moist S.W. wind was crossed at noon by a cold brisk gale from the North, and their union immediately produced a desirable shower of rain, after a dry period of seventeen days. This change was succeeded by a very dry gale from the North-east till the 30th; and although the 27th and 28th were very fine sunny days, with but few clouds, yet the sunshine was remarkably turbid in colour, which may have been caused by small dust raised by the powerful land gale, and mixing with the vapour arising from the earth. The aridity of the air near the earth was remarkable for absorbing aqueous vapour from the 24th to the 30th; as during the six days, under somewhat more than a mean pressure of the atmosphere, with a mean temperature of 65° where the water was exposed, the mean dew-point about 53°, and strong gales from the N. and N.E., the quantity that actually evaporated from a cubic foot of water (allowing it to contain 137,272 grains) was *one-eighth part* of the whole, or 6·3 grains per minute from its surface, which is one-seventh more than calculations on the theory of evaporation afford under similar circumstances, taking into consideration the form of the area, and the greatest force of the gales.

The atmospheric and meteoric phænomena that have come within our observations this month, are five parhelia, four solar and three lunar halos, lightning once, and seven gales of wind, or days on which they have prevailed; namely, two from the North, and five from the North-east.

REMARKS.

London.—May 1—4. Very fine. 5. Fine morning: cloudy. 6. Drizzly: very fine. 7. Fine. 8—13. Very fine. 14. Hazy morning: fine. 15. Very fine: slight rain at night. 16. Cloudy: very fine. 17—23. Very fine. 24. Very fine: heavy rain in the afternoon. 25. Cloudy, with strong gale at night. 26—28. Very fine. 29, 30. Cloudy. 31. Very fine.

Penzance.—May 1—3. Fair. 4. Fair: rain. 5. Rain: fair. 6. Clear. 7, 8. Fair. 9, 10. Clear. 11. Fair. 12. Clear: rain at night. 13, 14. Fair. 15—22. Clear. 23. Fair: a shower at night. 24, 25. Clear. 26. Fair. 27, 28. Clear. 29. Fair. 30, 31. Clear.

Boston.—May 1. Cloudy. 2. Cloudy: showery during the day. 3, 4. Fine. 5. Cloudy. 6. Fine: showery early A.M. 7—22. Cloudy. 23. Fine. 24. Cloudy. 25. Fine. 26. Cloudy. 27, 28. Fine. 29—31. Cloudy.

Meteoro-

Days of Month, 1829.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.									
May 1	29·710	29·680	29·90	29·88	29·67	29·66	29·11	59	46	57	43	62	50	49	W.	NW.	W.	W.	...	...	...	...	...
2	29·728	29·698	29·85	29·83	29·70	29·68	29·10	64	44	58	48	60	47	52	SW.	W.	SW.	W.	...	...	...	0·040	...
● 3	29·673	29·582	29·70	29·65	29·65	29·54	29·16	61	43	59	48	62	45	55	S.	W.	SW.	W.	0·25	...	...	·030	0·13
4	30·052	29·785	29·95	29·85	29·97	29·77	29·20	64	39	58	45	58	44	55	W.	SW.	NW.	calm	...	...	0·060	...	...
5	30·044	29·999	29·94	29·75	30·00	29·94	29·45	62	50	58	48	63	53	54	W.	S.	S.	calm	...	0·07	·280	·070	...
6	30·011	29·948	30·00	29·95	29·96	29·89	29·27	65	41	58	48	63	45	57	SW.	W.	SW.	W.	·25	·05	...	...	·09
7	30·117	30·004	30·20	30·08	30·06	29·97	29·[illegible]	61	41	57	47	59	37	56·5	SW.	NW.	W.	W.	...	...	...	·085	...
8	30·237	30·161	30·25	30·22	30·13	30·13	[illegible]	62	45	60	49	64	[illegible]	[illegible]	W.	W.	W.	calm	...	...	...	...	...
9	30·168	30·077	30·20	30·15	30·11	30·04	[illegible]	67	40	60	49	64	46	[illegible]	NE.	W.	W.	calm	·20	...	...	...	...
☽ 10	30·071	30·051	30·08	30·00	30·06	29·97	[illegible]·47	71	43	64	48	63	49	[illegible]	E.	N.E.	SE.	calm	...	...	...	...	...
11	30·049	29·990	29·90	29·88	29·95	29·90	29·53	65	40	57	52	64	50	59	E.	SE.	E.	E.	...	...	...	...	...
12	29·973	29·908	29·88	29·85	29·87	29·82	[illegible]·47	65	42	65	51	65	51	58	E.	[illegible]	SE.	E.	·50	...	...	...	...
13	29·956	29·936	29·90	29·80	29·92	[illegible]86	29·43	69	39	63	52	63	50	61·5	NE.	SW.	E.	E.	...	...	·150	...	...
14	29·975	29·930	30·02	30·00	29·92	[illegible]	29·37	73	[illegible]	62	47	64	47	60	W.	NW.	W.	W.	...	...	...	...	...
15	30·036	29·972	30·04	30·02	[illegible]	29·92	29·35	74	50	61	[illegible]	[illegible]	50	[illegible]	NE.	NW.	NW.	W.	·30	·04	...	...	...
16	30·123	30·076	30·06	30·08	[illegible]	30·01	29·5	60	41	62	[illegible]	[illegible]	47	57·5	E.	NE.	SE.	W.	...	...	...	...	...
17	30·129	30·113	30·10	30·03	[illegible]	30·07	29·5[illegible]	[illegible]	38	[illegible]	50	[illegible]	47	60	E.	NE.	E.	calm	...	...	...	...	...
○ 18	30·073	29·972	30·08	30·04	30·0[illegible]	29·90	29·40	[illegible]	44	64	50	64	[illegible]	61	E.	NE.	NE.	calm	·55	...	...	...	...
19	29·906	29·899	29·95	29·95	29·85	29·83	29·3[illegible]	70	40	[illegible]	49	69	5[illegible]	61	E.	NW.	NE.	calm	...	...	...	...	...
20	29·998	29·926	29·97	29·95	29·90	[illegible]6	29·46	73	46	[illegible]	[illegible]	72	[illegible]4	61·5	NE.	NE.	NE.	E.	...	...	...	...	...
21	30·124	30·064	30·02	30·00	30·02	30·00	29·56	71	41	58	54	73	47	53·5	E.	NE.	NE.	E.	·90	...	...	...	...
22	30·159	30·123	30·10	30·05	30·10	30·07	29·60	73	43	[illegible]	52	[illegible]	50	57	E.	SE.	N.	calm	...	...	...	...	...
23	30·193	30·154	30·20	30·20	30·17	30·17	2[illegible]·68	80	41	66	[illegible]	[illegible]	53	60	SW.	SW.	SW.	calm	...	...	...	...	...
24	30·267	30·236	30·30	30·18	30·21	30·16	29·63	6[illegible]	44	[illegible]	54	68	49	61	NE.	NW.	N.	calm	·50	·36	·070	·070	...
☾ 25	30·441	30·399	30·50	30·45	30·32	30·31	29·87	62	45	58	49	61	49	56	NE.	NE.	N.	E.	·25	...	...	...	...
26	30·439	30·335	30·30	30·20	30·23	30·21	29·94	69	46	59	48	65	48	5[illegible]	NE.	NE.	NE.	NE.	·30	...	...	...	...
27	30·298	30·246	30·20	30·20	30·18	30·16	29·77	72	47	65	51	67	50	54·5	NE.	N.	NE.	E.	·30	...	...	...	...
28	30·229	30·157	30·18	30·16	30·13	30·10	29·66	74	47	66	52	70	50	60·5	NE.	NE.	NE.	E.	·30	...	...	...	...
29	30·207	30·192	30·15	30·15	30·13	30·12	29·61	66	43	66	54	67	50	56	NE.	NE.	NE.	calm	·15	...	...	...	...
30	30·200	30·161	30·15	30·15	30·14	30·11	29·71	[illegible]	41	69	54	64	45	56·5	NE.	N.	NE.	calm	·20	...	...	...	...
31	30·195	30·170	30·20	30·18	30·18	30·13	29·70	69	44	64	52	68	52	52	W.	N.	W.	calm	·10	...	...	...	...
Aver.:	30·441	29·582	30·50	29·65	30·32	29·54	29·50	80	38	69	43	73	44	57·0					5·05	0·52	0·560	0·295	0·22

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

AUGUST 1829.

XII. *An Account of some Experiments on the Torpedo.* *By Sir* HUMPHRY DAVY, *Bart. F.R.S.**

AMIDST the variety of researches which have been pursued respecting the different forms and modes of excitation and action of electricity, it is surprising to me that the electricity of living animals has not been more an object of attention, both on account of its physiological importance, and its general relation to the science of electro-chemistry.

In reading an account of the experiments of Walsh, it is impossible not to be struck by some peculiarities of the electricity of the organ of the Torpedo and Gymnotus; such as its want of power to pass through air, and the slight effects of ignition produced by the strongest shocks: and though Mr. Cavendish, with his usual sagacity, compared its action to that of a battery weakly charged, when the electricity was large in quantity but low in intensity, yet the peculiarities which I have just mentioned are not entirely in harmony with this view of the subject.

When Volta discovered his wonderful pile, he imagined he had made a perfect resemblance of the organ of the gymnotus and torpedo; and whoever has felt the shocks of the natural and artificial instruments, must have been convinced, as far as sensation is concerned, of their strict analogy. After the discovery of the chemical power of the voltaic instrument, I was desirous of ascertaining if this property of electricity was possessed by the electrical organs of living animals; and being in 1814 and 1815 on the coast of the Mediterranean, I made use of the opportunities which offered themselves of making experiments on this subject. Having obtained in the Bay of

* From the Philosophical Transactions for 1829. Part I.

Naples, in May 1815, two small torpedos alive, I passed the shocks through the interrupted circuit made by silver wire through water, without being able to perceive the slightest decomposition of that fluid; and I repeated the same experiments at Mola di Gaeta, with an apparatus in which the smallest possible surface of silver was exposed, and in which good conductors, such as solutions of potassa and sulphuric acid, were made to connect the circuit; but with the same negative results.

Having obtained a larger torpedo at Rimini in June in the same year, I repeated the experiments, using all the precautions I could imagine, with like results; and at the same time I passed the shock through a very small circuit, which was completed by a quarter of an inch of extremely fine silver wire, drawn by the late Mr. Cavendish for using in a micrometer, and which was less than the $\frac{1}{1000}$dth of an inch in diameter; but no ignition of the wire took place. It appeared to me after these experiments, that the comparison of the organ of the torpedo to an electrical battery weakly charged, and of which the charged surfaces were imperfect conductors, such as water, was more correct than that of the comparison to the pile: but on mentioning my researches to Signor Volta, with whom I passed some time at Milan that summer, he showed me another form of his instrument, which appeared to him to fulfill the conditions of the organs of the torpedo; a pile, of which the fluid substance was a very imperfect conductor, such as honey or a strong saccharine extract, which required a certain time to become charged, and which did not decompose water, though when charged it communicated weak shocks.

The discovery of Œrsted of the effects of voltaic electricity on the magnetic needle, made me desirous to ascertain if the electricity of living animals possessed this power; and after several vain attempts to procure living torpedos sufficiently strong and vigorous to give powerful shocks, I succeeded in October of this year, through the kind assistance of George During, Esq., His Majesty's Consul at Trieste, in obtaining two lively and recently caught torpedos, one a foot long, the other smaller. I passed the shocks from the largest of these animals a number of times through the circuit of an extremely delicate magnetic electrometer, (of the same kind, but more sensible, than that I have described in my last paper on the electro-chemical phænomena, which the Royal Society has honoured with a place in their Transactions for 1826,) but without perceiving the slightest deviation of or effect on the needle; and I convinced myself that the circuit was perfect, by making my

my body several times a part of it, holding the silver spoon, by which the shock was taken, in one hand, wetted in salt and water, and keeping the wire connected with the electrometer in the other wet hand; the shocks which passed through the reduplications of the electrometer were sufficiently powerful to be felt in both elbows, and once even in the shoulders.

These negative results may be explained by supposing that the motion of the electricity in the torpedinal organ is in no measurable time, and that a current of some continuance is necessary to produce the deviation of the magnetic needle; and I found that the magnetic electrometer was equally insensible to the weak discharge of a Leyden jar as to that of the torpedinal organ; though whenever there was a continuous current from the smallest surfaces in voltaic combinations of the weakest power, but in which some chemical action was going on, it was instantly and powerfully affected. Two series of zinc and silver, and paper moistened in salt and water, caused the permanent deviation of the needle several degrees, though the plates of zinc were only $\frac{1}{6}$th of an inch in diameter.

It would be desirable to pursue these inquiries with the electricity of the gymnotus, which is so much more powerful than that of the torpedo: but if they are now to be reasoned upon, they seem to show a stronger analogy between common and animal electricity, than between voltaic and animal electricity: it is however I think more probable that animal electricity will be found of a distinctive and peculiar kind.

Common electricity is excited upon non-conductors, and is readily carried off by conductors and imperfect conductors. Voltaic electricity is excited upon combinations of perfect and imperfect conductors, and is only transmitted by perfect conductors or imperfect conductors of the best kind.

Magnetism, if it be a form of electricity, belongs only to perfect conductors; and, in its modifications, to a peculiar class of them.

The animal electricity resides only in the imperfect conductors forming the organs of living animals, and its object in the œconomy of nature is to act on living animals.

Distinctions might be established in pursuing the various modifications or properties of electricity in these different forms; but it is scarcely possible to avoid being struck by another relation of this subject. The torpedinal organ depends for its powers upon the will of the animal. John Hunter has shown how copiously it is furnished with nerves. In examining the columnar structure of the organ of the torpedo, I have never been able to discover arrangements of different conductors similar to those in galvanic combinations, and it seems not im-

probable that the shock depends upon some property developed by the action of the nerves.

To attempt to reason upon any phænomena of this kind as dependent upon a specific fluid, would be wholly vain.

Little as we know of the nature of electrical action, we are still more ignorant of the nature of the functions of the nerves. There seems, however, a gleam of light worth pursuing in the peculiarities of animal electricity, its connection with so large a nervous system, its dependence upon the will of the animal, and the instantaneous nature of its transfer, which may lead when pursued by adequate inquirers to results important for physiology.

The weak state of my health will, I fear, prevent me from following this subject with the attention it seems to deserve; and I communicate these imperfect trials to the Royal Society, in the hope that they may lead to more extensive and profound researches.

October 24, 1828. Lubiana, Illyria.

XIII. *On* Hadley's *Sextant.*

(*From* Prof. Encke's *Ephemeris for* 1830, *p.* 285.)

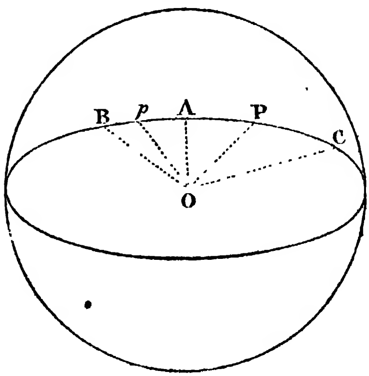
IN instruments of reflexion, the measurement of angles is effected by the coincidence of a ray coming directly from an object into the eye, with one from another object that has undergone one or two reflexions. The coincidence, in this case, supplies the place of the observation of the second object in other instruments for measuring angles by direct vision, and does away the necessity of investigating, whether the radius determined by the first reading has remained unchanged, or at least parallel to its former position. In the case of reflecting instruments, we have only to regard the angles which the different lines form with each other, and not their absolute position in space; and it will therefore be sufficient, instead of the real lines, to introduce lines parallel to them all, passing through one point; and in this manner all the investigations relating to them will be converted into problems of spherical trigonometry.

Let O (fig. 1.) be the centre of the division, and let a sphere of any diameter be described about this point. The intersection of the divided plane of the sextant with this sphere will be a great circle. If the divided arc is to show the correct value of every angle, the direct and the reflected rays, the latter of which supplies the place of the second bisection, must be entirely in this plane, from which we derive these conditions

of

of a correct measurement; viz. the line of collimation of the telescope must be parallel to the plane of the sextant, and both mirrors must be perpendicular to it. In this supposition, let O A be parallel to the line of collimation, and p that pole of the plane parallel to the small mirror which answers to the back of it; in the same manner let P be the pole of the plane of the great mirror, but the one answering to its reflecting surface. By our assumption, A, p, P are in the great circle of the plane of the sextant. In order to find the position of the objects whose angle is measured by this position of the mirrors, we will not follow the path of the ray of light in its real direction from the object to the eye, but in the contrary direction from the eye to the object. It is well known that the path of the ray is the same if we exchange the luminous and the illuminated points. The direct ray has the direction OA. The doubly reflected one coinciding with it has at first the same direction. In this direction it strikes the small mirror, and is reflected by it to the large mirror. If we make p B on the other side of $p = p$ A in the great circle of the plane of the sextant, BO will be the direction of the ray after the first reflexion. In the same manner OC will be its direction after the second reflexion, if we make PC = PB on the other side of P. The objects whose angle is now measured are A and C. This construction immediately shows the law on which this measurement depends; for as p bisects the arc AB, and P the arc B C, we have p P $= \frac{1}{2}$ A C...... or the angle of the poles of the two mirrors, which is equal to that of the planes of the mirrors themselves, is always one half of the real angle. On the sextant the double angles are accordingly always marked.

Fig. 1.



In this manner it is possible to follow the path of the ray after three, four, or any number of reflexions. For greater numbers, however, the analytical form would be more convenient, and the symmetry of the formulæ would likewise be more perfect, if throughout the same poles, corresponding either to the reflecting surfaces or to the opposite ones, were made use of, as also either the points where the ray issues from, or those where it enters into the surface of the sphere.

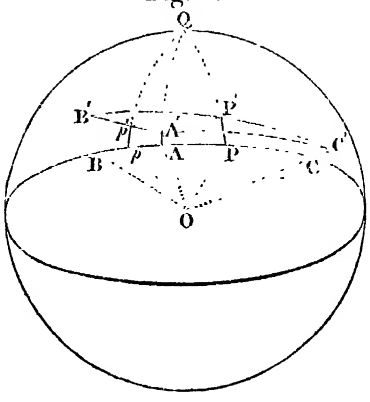
The errors to which this measurement is liable, independent of

of the incidental errors of observation, are partly founded on the nature of the instrument. Among these are the errors of excentricity and division, which in a good instrument can be ascertained only by uncommonly accurate mechanical means. The remeasurement of known angles, measurement of all angles round the horizon, if there is an opportunity of so doing, are means which will in common cases enable to ascertain the existence and approximate amount of such errors. Other sources of error arise from the imperfect nature of the materials; and although probably existing in every instrument, they are in the better ones inclosed within narrow limits. To these we may reckon the difficulty of producing perfectly plain glass mirrors quite free from a prismatic form in their two reflecting surfaces. The distinctness of the images will determine the quality of the mirrors; and although we shall suggest below a method of taking into account the errors, arising from a prismatic form of the mirrors, it would be useless to apply it, as it would be impossible to obtain accurate angles by mirrors so formed. The dark glasses used in observations of the sun may likewise introduce errors. If it is possible to apply them in reversed positions, and if the index error is determined with and without coloured glasses, one may determine the error caused by them. This error will be of no effect if the error of index is determined with the same coloured glasses with which the measurement is performed. In all those points it will be necessary to rely on the accuracy of the artist, if the deviations are not too gross.

The errors which then remain, arise from the non-fulfilment of the above-stated three conditions.

Let us now assume that the sextant had all three defects, that the line of collimation is not parallel, nor either of the mirrors perpendicular to the plane of the instrument; and let again BC be the plane of the sextant, and let the letters have the same signification as in fig. 1. If Q is the pole of the plane of the sextant, the line parallel to the line of collimation will not be O A, but let it be O A′, and let A′ be in the circle Q A. The arc A A′, the inclination of the line of collimation, may be $= i$. In the same manner let us assume that the pole

Fig. 2.



pole of the small mirror is in p', that of the large one in P', and that these points are in the great circle, Qp and QP. Let us designate these inclinations of the small mirror pp', and of the large one PP', by k and l, and let us consider these quantities as positive if the points A', p', P' are situate above the divided surface.

In this position we shall still read off the arc $pP = \alpha$, or in reality 2α, but we shall no more bring to coincidence the rays proceeding from A and C. In order to find the objects for which the coincidence takes place, we proceed as above. The object seen by direct vision is A'. Let us assume a great circle to pass through A' and p', and on it we take $p'B' = p'A'$ on the other side of p'; in the same manner we assume a circle passing through the points B' thus determined, and the point P', and on it we take in like manner $C'P' = B'P'$. Then C' will be the second object. The arc $A'C'$ is the angle which is to be measured; and if we denote it by $2\alpha'$, the correction of the angle read off on the sextant will be .... $+ 2(\alpha' - \alpha)$.

In the spherical triangle $A'B'C'$ thus formed, two sides are bisected by the points p' and P', and the relative situation of the points of bisection, as also that of one of the angular points A', are given by the quantities i, k, l, which are supposed to be known; the angle $pQP = \alpha$, which is read off on the sextant; and the angle pQA, which is constant by the construction of the sextant, being the complement of the inclination of the line of collimation to the plane of the small mirror. Let us denote this latter angle pQA by β. The problem: to find $A'C' = 2\alpha'$ by these quantities must, on account of the intimate connection between plane and spherical trigonometry, lead to very simple expressions, as the relation is immediately given by the former.

If we denote the sides opposite to the angles A', B', C', by a', b', c', and assume $p'P' = \frac{1}{2}b''$, and the angle $P'p'A' = B''$, we have in the triangle $p'B'P'$ these equations:

$$\cos\tfrac{1}{2}b'' = \cos\tfrac{1}{2}a' \cos\tfrac{1}{2}c' + \sin\tfrac{1}{2}a' \sin\tfrac{1}{2}c' \cos B'.$$

$$\sin\tfrac{1}{2}b'' \sin B'' = \sin\tfrac{1}{2}a' \sin B'.$$

$$\sin\tfrac{1}{2}b'' \cos B'' = -\sin\tfrac{1}{2}c' \cos\tfrac{1}{2}a' + \cos\tfrac{1}{2}c' \sin\tfrac{1}{2}a' \cos B'.$$

As $$\cos b' = \cos a' \cos c' + \sin a' \sin c' \cos B', \text{ and}$$

$$\cos b'' = \cos\tfrac{1}{2}b''^2 - \sin\tfrac{1}{2}b''^2$$

we obtain by squaring these equations, after some reductions:

$$\cos b'' = \cos b' - 2\sin\tfrac{1}{2}c'^2 \sin\tfrac{1}{2}a'^2 \sin B'^2$$

$$= \cos b' - 2\sin\tfrac{1}{2}c'^2 \sin\tfrac{1}{2}b''^2 \sin B''^2.$$

Denoting the perpendicular line from A' or B' to $p'P'$ by ϖ, this equation may be written thus: $\sin\tfrac{1}{2}b' = \sin\tfrac{1}{2}b'' \cos\varpi$

in

in which form it agrees with the result deduced from the plane triangles.

Agreeably to the notation here given, we have

$$b' = 2\alpha', \quad c' = 2p'A', \quad b'' = 2p'P'$$

$$B'' = Qp'A' - Qp'P';$$ and from the triangles $Qp'A'$ and $Qp'P'$ we have these equations:

$$\cos\tfrac{1}{2}c' = \sin k \,.\, \sin i + \cos k \cos i \cos\beta$$
$$\sin\tfrac{1}{2}c' \,.\, \sin Qp'A' = \cos i \sin\beta$$
$$\sin\tfrac{1}{2}c' \,.\, \cos Qp'A' = \cos k \sin i - \sin k \cos i \cos\beta$$
$$\cos\tfrac{1}{2}b'' = \sin k \sin l + \cos k \,.\, \cos l \,.\, \cos\alpha$$
$$\sin\tfrac{1}{2}b'' \sin Qp'P' = \cos l \,.\, \sin\alpha$$
$$\sin\tfrac{1}{2}b'' \cos Qp'P' = \cos k \,.\, \sin l - \sin k \cos l \,.\, \cos\alpha.$$

From the latter three we obtain

$$\cos b'' = 1 - 2\sin\alpha^2 \,.\, \cos l^2 - 2(\sin l \cos k - \sin k \cos l \,.\, \cos\alpha)^2$$
$$= \cos 2\alpha + 2\sin\alpha^2 \sin l^2 - 2(\sin l \cos k - \sin k \cos l \,.\, \cos\alpha)^2$$

and from the second, third, fifth, and sixth, we derive

$$\sin\tfrac{1}{2}c' \,.\, \sin\tfrac{1}{2}b'' \sin B'' = \begin{cases} \quad \cos i \,.\, \cos k \sin l \,.\, \sin\beta \\ + \cos i \cos l \sin k \sin(\alpha - \beta) \\ - \cos k \,.\, \cos l \sin i \sin\alpha \end{cases}$$

hence, having this equation

$$\cos 2\alpha' = \cos b'' + 2\sin\tfrac{1}{2}c'^2 \sin\tfrac{1}{2}b''^2 \sin B''^2,$$

we derive this strictly exact formula:

$$\sin(\alpha' - \alpha)\sin(\alpha' + \alpha) =$$
$$\{ - \cos l^2 (\tan l \sin\alpha)^2 \qquad \text{(A)}$$
$$+ \cos k^2 \,.\, \cos l^2 (\tan l - \tan k \cos\alpha)^2$$
$$- \cos i^2 \cos k^2 \cos l^2 (\operatorname{tg} l \sin\beta + \operatorname{tg} k \sin(\alpha - \beta) - \tan i \sin\alpha)^2 \}$$

The quantities i and k are by their nature constant as long as the sextant is not changed. The quantity l, however, may change with the angle. Its evanescence depends on two circumstances: 1st, that the axis of rotation is vertical; and 2dly, that the reflecting plane is parallel to the axis of rotation. If the first condition is fulfilled without the second, the pole describes a small circle parallel to the plane of the sextant, and l is constant. If the second condition is complied with without the first, the pole describes a great circle inclined to the plane, and l is changeable with the angle. If neither of these conditions is complied with, the pole describes a small circle inclined to the plane, and l is likewise variable; we will assume the latter most general case, and denote by γ the distance from the pole of the plane of the sextant, of the point in which the axis of rotation produced upwards intersects the sphere, and by u the angle at the pole, between the arcs γ and Qp (counted in the order of the divisions): and lastly, by δ the inclination of the plane of the mirror to the axis of rotation (positive

sitive if its pole is above the plane perpendicular to the axis of rotation). We then have this equation:

$$\sin \delta = \sin l \,.\, \cos \gamma + \cos l \sin \gamma \cos (u - \alpha).$$

For determining the quantities δ, γ, u, it is necessary to know three values of l, with the corresponding values of α, and the problem will then agree with the determination of the rotation of the sun from the spots on its disk, or with the problem of determining time, latitude and altitude, from three unknown but equal altitudes, of which Prof. Gauss has given an elegant solution in the "Monthly Correspondence" by M. de Zach, Oct. 1808. In the present case the smallness of the quantities γ and δ, and the possibility of ascertaining the different values of α very exactly, allow an abbreviation.

Almost all sextants are capable of measuring 120°. If the sextant is therefore placed in the three positions in which the angles read off are 0°, 60°, 120°, and if the corresponding value of l is read off in every situation, we shall have

$$\begin{aligned} \alpha &= 0^\circ & l &= l_0 \\ \alpha &= 30^\circ & l &= l_1 \\ \alpha &= 60^\circ & l &= l_2 \end{aligned}$$

and thence with abundant accuracy

$$\begin{aligned} \delta &= (2 l_0 - 3 l_1 + 2 l_2) + (l_0 - 2 l_1 + l_2)\sqrt{3} \\ \gamma \sin u &= (\ l_0 - 2 l_1 + \ l_2) + (l_0 - \ l_1 \qquad)\sqrt{3} \\ \gamma \cos u &= (\ l_0 - 3 l_1 + 2 l_2) + (l_0 - 2 l_1 + l_2)\sqrt{3} \end{aligned}$$

For prismatic mirrors the relative situation of the two planes might be hereby determined, if it were possible to distinguish the two images. The formulæ here given will only have an application in practice, if we have the particular purpose and adequate means to determine every thing in the most exact manner. For the use of the sextant approximate methods will be sufficient. In most sextants of recent construction the screws for adjusting the position of the large mirror are omitted. It is to be supposed that the artist will have taken all possible pains to render the axis of rotation perpendicular to the plane, so that in the equation $l = \delta - \gamma \cos (u - \alpha)$ the last term may be neglected, or that at least the variation of it may be neglected, the influence of l being besides very small in itself. The most simple adjustment which may be performed with the greatest accuracy, is the parallel position of the two mirrors by bringing the two images of the same terrestrial object to coincidence in a position for which α is about 0. If we suppose this adjustment to have been made, we have $k = l$, and l may be considered as constant. The formula (A) will then be:

$$\sin(\alpha' - \alpha) = \frac{4 \sin \tfrac{1}{2} \alpha^2}{\sin(\alpha' + \alpha)} \begin{cases} - \sin l^2 (\cos \alpha + \sin l^2 \sin \tfrac{1}{2} \alpha^2) \\ - \cos i^2 \cos l^2 (\operatorname{tang} l \cos (\tfrac{1}{2} x - \beta) - \operatorname{tang} i \cos \tfrac{1}{2} \alpha)^2 \end{cases}$$

If we now call the angle read off on the sextant s, so that

$s = 2\alpha$, and make the abbreviations which the nature of the case allows, we shall have for the correction of s this equation:

$$\Delta s = -2 \text{ tang } \tfrac{1}{4} s \{ l^2 + \sec \tfrac{1}{2} s \, (l \cos (\tfrac{1}{4} s - \beta) - i \cos \tfrac{1}{4} s)^2 \}. \quad \text{(B)}$$

The comparison of this formula with Bohnenberger's rules will show, as might have been expected, a perfect agreement. For $k = l = 0$ we have by (B) $\Delta s = - i^2 \text{ tang } \tfrac{1}{2} s$ (Bohnenberger, p. 123). For $i = 0$ and $l = 0$, we have by (A)

$$\alpha' - \alpha = k^2 \frac{\cos \alpha^2 - \sin^2 (\alpha - \beta)^2}{\sin 2\alpha}\text{ ; consequently,}$$

$$\Delta s = \frac{2 \cos \beta \cos (s - \beta)}{\sin s} k^2 = \frac{2 \cos \beta^2}{\text{tang } s} k^2 + \sin 2 \beta \, k^2$$

The last term being constant for all angles, does not come into consideration, because it is the same in determining the index error. The formula then agrees with Bohnenberger's, p. 132. In the case treated by Bohnenberger, § 88, it is to be observed that if $k = l$, and l constant, and if besides the line of collimation of the telescope is to be in the plane perpendicular to both mirrors, i is variable with the angle. For every point P′ of a small circle gives with the fixed point p' another great circle, in every one of which A′ is to be situated. If i is determined agreeably to this condition, we shall obtain

$$\text{tang } i = \frac{\cos (\tfrac{1}{4} s - \beta)}{\cos \tfrac{1}{4} s} \text{ tang } l$$

By this equation the last term in (B) disappears altogether, and the correction becomes

$$\Delta s = - 2 l^2 \text{ tang } \tfrac{1}{4} s \quad \text{(Bohnenberger, p. 129.)}$$

The formula might, therefore, likewise be written thus: Let i^1 be the elevation above the plane of the sextant of the point in which the great circle passing through the poles of both mirrors intersects the vertical plane of the sextant in which the object seen by direct vision is situated; and we have,

$$\Delta s = - (i^1 - i^2) \text{ tang } \tfrac{1}{2} s - 2 \text{ tang } \tfrac{1}{4} s \, . \, l^2. \quad \text{(C)}$$

It is apparent from this formula, that if the errors had not been considered at the same time, but each singly, and their effects had been added together, the only difference would have been that i^1 would have been assumed $= 0$. The angle β which we have introduced is, indeed, not immediately used in measuring angles. But besides its use in the formulæ for correction, it is used in some applications of the instrument; so that it is worth while to ascertain it for every sextant. Thus we can determine by it the limit of the angles which can be measured by the sextant. All reflexion ceases, when the great mirror is inclined to the small one under an angle of $90° - \beta$. The limit of measurable angles is therefore $= 180° - 2\beta$, and for this reason β is in all sextants of nearly the same magnitude.

It

It serves likewise to correct the index error if determined by terrestrial objects. If we understand by index error always that quantity which is to be subtracted from every angle read off, in order to obtain the correct value, an assumption by which the arc of excess is to be considered as negative, and then draw the triangle between the two mirrors and the object, and call the distance of the object from the small mirror d, the distance of the two mirrors f, the angle read off at the coincidence of the two images c_1, and the true index error c_0, we have this equation: $\tan (c_0 - c_1) = \frac{f \sin 2\beta}{d + f \cos 2\beta}$: and therefore, $c_0 = c_1 + \frac{f}{d} \sin 2\beta - \frac{1 f^2}{2 d^2} \sin 4\beta$. The angle β is likewise requisite if it is thought worth while to ascertain the point to which the angle measured really belongs. In the case of a positive reading, the rays of light will intersect in the prolongation of the line of collimation, taken in the direction from the small mirror to the telescope. If we call the distance of the point of intersection from the small mirror, assumed as positive in this direction g, and if we denote the angle read off uncorrected by the error of the index by s, we shall have

$$g = f \frac{\sin (s - c_0 + 2\beta)}{\sin (s - c_0)} = f \cos 2\beta + f \frac{\sin 2\beta}{\tan (s - c_0)},$$ whence

results the possibility of determining the distance of a near object provided f and c_0 could be ascertained with sufficient accuracy.

Lastly, the angle β is of use when the sextant is to be employed as a heliotrope. If the second object c (fig. 1.) were the sun, the object which lies in the direction O B would receive the reflected rays of the sun. If the object A is to receive them, the pole P is to be moved forward in the order of the divisions by the quantity β, or, as on the sextant the double angles are read off, the index must be advanced 2β. The operations are therefore as follows: Place the plane of the sextant into the plane of the object which is to receive the rays of the sun by reflexion and the sun, measure the angle as usual, and advance the index 2β beyond the division read off without changing the plane of the instrument.

It is clear that a stand is indispensably necessary for this operation. As long as any part of the sun's disk illuminates the intersection of the cross wires, for which the angle β has been determined, the object will receive light; this time will amount to about two minutes. The measurement of the angle is, therefore, to be repeated every two or three minutes, and that point is to be taken which by the motion of the sun first passes the cross wires. If the sun is the object directly seen, the imme-

 diate

diate inspection will determine the moment when the instrument is to be changed; in the other case the length of the time elapsed can be the only guide. With this use of the instrument I became acquainted through Prof. Gauss's first trials of heliotropic observations, before the proper instruments which he had devised were finished. Trials made at a distance of nine (41½ English) miles, in which the sun was seen directly, succeeded perfectly; and even trials made at a distance of fourteen (64½ English) miles under the most unfavourable circumstances, the sun being seen by reflexion immediately upon rising, gave a satisfactory result.

[To be continued.]

XIV. *Viscount* Cole *and Mr.* Philip Egerton's *Account of the Destruction of the Cave of Kühloch, in Franconia.*

Dear Sir, Oxford, July 8, 1829.

I BEG to make public, through your Journal, an account I have just received from Lord Cole and Philip Egerton, Esq. of the recent destruction of the most interesting and curious deposit of organic remains in Germany; viz. that in the cave of Kühloch in Franconia, and also of another cave of less importance adjacent to it.

In my *Reliquiæ Diluvianæ* (page 137 et seq. and Pl. 18), I have given a detailed description and drawing of the Cave of Kühloch*. The enormous quantity of black animal earth derived from pulverized bones, constituted its peculiar feature; and I have endeavoured to explain the causes of this peculiarity by the form and features of its entrance, which, as they have now been nearly obliterated, and may hereafter be found not to correspond with my description, I wish to record the fact and time of their obliteration, by the publication of the following letter. And remain,

Your obedient servant,

To R. Taylor, Esq. William Buckland.

My dear Sir, Schaffhausen, June 26, 1829.

Lord Cole and myself are just returned to Schaffhausen from a three weeks visit to the antediluvian caverns of Franconia; and knowing the great interest you feel in their welfare, I write to inform you of the melancholy fact of the total destruction of the deposit of bones in the caves of Kühloch and Rabenstein.

* Dr. Buckland's account of the cave of Kühloch will be found in Phil. Mag. vol. lxii. p. 112; and also, together with M. Chevreul's analysis of the animal earth, in Ann. Phil. N.S. vol. ix. p. 284.—Edit.

Rabenstein. His Majesty the king of Bavaria having announced his intention to visit Rabenstein, the owner of that castle has thought fit to prepare these two caves for his reception; in order to do which, he has broken up the whole of the floors, pounding the larger stones and bones to the bottom for a foundation, and spreading the earth and finer particles to form a smooth surface over them. Conceive our horror on arriving at Kühloch, at finding thirty men at work, wheeling out the animal earth, to level the inclination of the entrance, by which you have so satisfactorily explained the phænomenon of the absence of pebbles and diluvial loam in this remarkable cavern. There was not a bone to be found there when we arrived; however, with a little management we contrived to obtain two beautiful fragments of lower jaws of hyæna, besides some very good bears' bones, and one ulna that had been broken during the animal's life, and the sharp edges of the fracture rounded off by the absorbents into a smooth stump. We likewise procured from one of the workmen, teeth of a fox, of a tiger, and molar tooth of the right lower jaw of rhinoceros,—all of which he said he picked up in Kühloch.

In the cave of Rabenstein they found very few bones, but a great many old coins and iron instruments. I am happy to say we also found in the cave of Zahnloch, the large block of stone which you describe as polished by the paws of the antediluvian bears; it was almost concealed by a pile of earth near the entrance of the side chamber in which it stands. The angles and surface of the block have certainly been rounded by some agent anterior to the formation of its present coat of stalagmite. I broke off this stalagmite in many places, and found the stone in the same state underneath, as in the parts that had not been encased by it. We have brought you a large specimen of it, in order that you may judge for yourself. We worked for six days in Gailenreuth, and were very lucky in finding an entire lower jaw of the *Felis spelæa*, a perfect pelvis of the *Ursus spelæus*, and a very good collection of hyæna, wolf, and fox teeth, besides bear's teeth and bones in abundance. We likewise found an immense quantity of fragments of old sepulchral urns. We found also the same in the caves of Zahnloch and Scharzfeld.

At Bonn, we obtained from Professor Goldfuss the tibia of a deer from the cave of Sundwick, cracked, and having the marks of hyæna's teeth, exactly corresponding with those on your tibia of an ox from Kirkdale. We procured also a gnawed rhinoceros bone from the same locality. Believe me,

My dear Sir, yours sincerely,

PHILIP DE MALPAS EGERTON.

XV. *Ana-*

XV. *Analysis of British and Foreign Ships of War.* *By* Mr. Major, *formerly of the School of Naval Architecture.*

[Continued from p. 46.]

Table III. *Analytical* Table *of French Ships of the Line.*

[Translated from the Ordinance of the Minister of the French Marine in 1786, and reduced to English Measurement.]

Nature of the Elements.	120 Guns	110 Guns.	80 Guns.	74 Guns	64 Guns.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Length from head to stern	209·48	198·29	196·16	181·23	166·31
Breadth moulded	53·3	52·77	51·17	47·44	43·71
Depth in hold	26·65	26·12	25·32	23·45	21·32
Draught of water, light { abaft	18·65	18·47	18·12	16·69	15·45
Draught of water, light { forward....	14·92	14·56	12·79	11·63	11·82
Draught of water, loaded { abaft	26·65	26·29	23·98	22·92	21·05
Draught of water, loaded { forward..	24·22	23·63	22·38	21·14	19·98
Total weight of ship and stores when victualled and furnished for six months	*Tons.* 5057·1	*Tons.* 4738·04	*Tons.* 3687·2	*Tons.* 2938·7	*Tons.* 2217·2
Difference between ships of the same rate	228·47	202·44	121·46	110·86	62·66
Weight of water displaced when light .... (per inch)..	22·65	20·24	18·31	15·09	12·29
Weight requisite to sink the ship one inch when loaded..........	27·95	25·06	21·3	19·5	15·9
Height of lower battery above water	*Ft.* 5·68	5·33	5·86	5·86	5·33
Number and calibre of guns on lower battery..................	32–36 P'	30–36 P'	30–36 P'	28–36 P'	26–14 P'
Do. on middle deck	34–24	32–24			
Do. on upper deck	34–12	32–12	32–24	30–18	28–12
Do. on quarter deck & forecastle	20–18	16–8	18–8	16–8	10–6
Equipage in war...Number of men ..	1098	1037	839	690	623
Do. in peace...Number of men	764	727	581	472	354
Weight of hull and masts..in tons...	2410	2313·6	1739·05	1385·26	1079·68
Height of centre of gravity from keel	*Ft.* 14·39	13·85	13·41	12·18	12·43
Distance of do. from centre of vessel..	2·39	1·42	1·68	2·69	1·59
Height of metacentre above centre of gravity	13·14	12·79	12·96	12·96	11·46
Weight of ordnance........in tons..	478·14	471·39	361·5	302·69	19.28
—— of cordage and rigging	318·12	258·35	236·18	212·08	154·24
—— of water for three months....	303·66	282·45	227·5	185·08	140·74
—— of butts and casks	50·13	47·24	38·56	30·85	23·14
—— of provisions for six months..	594·79	586·59	431·39	354·27	268·47
—— of equipage	132·07	124·84	100·74	82·9	63·62
—— of stores, captain and officers'	61·69	55·91	33·74	28·92	24·58
—— of clothing and boats........	38·56	34·6	28·92	24·1	19·28
—— of iron ballast	482·0	385·6	347·04	236·18	173·52
—— of stone or shingle ballast....	187·98	177·37	142·67	96·4	77·12
	2647·14	2424·34	1948·24	1553·47	1137·51
Weight of hull and masts	2410·0	2313·6	1739·05	1385·26	1079·68
Total displacement, as above	5057·14	4737·94	3687·29	2938·73	2217·19

TABLE

Table IV.

Analytical Table *of French Frigates.*

[Translated from the Ordinance of the Minister of the French Marine in 1786, and reduced to English Measurement.]

Nature of the Elements.	18 Pounder	12 Pounder	Corvette 20 Guns	Advice Boats.
	Feet.	*Feet.*	*Feet.*	*Feet.*
Length from head to stern	153·2	144·98	119·4	85·28
Breadth moulded	38·91	36·78	30·2	25·58
Depth in hold....................	19·18	18·65	15·27	12·79
Draught of water abaft (light).....	13·32	12·00	11·27	8·79
Ditto forward	9·14	9·06	8·96	8·52
Load draught of water abaft	17·05	16·34	14·12	12·26
Ditto forward..........	16·16	14·65	12·52	10·77
Total weight of ship and stores, with six months provisions....in tons	1425·75	1120·16	526·34	256·4
Difference between ships of the same class	50·12	42·41	22·17	21·16
Light displacement for an inch	10·05	9·16	6·26	4·58
Weight requisite to sink the ship an inch when loaded..	12·87	10·8	7·23	3·37
—— in hull and masts	641·06	562·01	256·4	135·92
—— of metal on gun deck.....	28–18 P	26–12 P	20–6 P	4–4 P
on quarter deck and forecastle .	12–8	6–6		
Number of crew, in war ...	314	261	120	50
in peace .	222	181	120	50
Height of guns above water	*Ft.* 6·92	6·39		
of centre of gravity from keel	9·7	9·1	6·9	6·5
Distance of centre of gravity before middle......................	1·3	1·2	2·7	4·4
Height of metacentre above centre of gravity.....................	12·7	11·61	8·6	7·1
	Tons.	*Tons.*	*Tons.*	*Tons.*
Weight of ordnance.............	126·2	82·9	37·59	2·89
of cordage and rigging, exclusive of masts.	123·3	88·68	46.27	23·13
Water for three months ...	86·76	70·3	32·77	18·3
Weight of casks...........	14·46	11·56	4·82	2·89
Provisions for six months ..	161·21	132·06	42·42	25·30
Weight of crew...........	37·59	30·83	14·46	6·04
Captain and officer's stores.	19·28	17·34	8·67	5·78
Men's clothing and boats...	17·35	14·45	12·54	8·66
Iron ballast...............	140·7	86·74	53·04	19·28
Shingle or stone ditto	57·84	23·13	17·35	9·64
Total weight of equipment.	784·69	558·15	269·9	121·98
Weight of hull and masts .	641·06	562·01	256·4	135·92
Total displacement....	425·7	120·16	526·34	257·38

Table V.

Analytical Table *of Swedish Ships of War.*

[Translated from Chapman's "Proportions for Ships of War," p. 82, Table No. 33, published at Carlskrona, 1806: the whole being reduced to English Measure.]

Nature of the Elements.	110 Guns.	94 Guns.	80 Guns.	74 Guns.	66 Guns.
	English Feet.				
Displacement, without the exterior planking = D in cubic feet......	141715·12	118931·3	97056·9	89383·1	82245·2
Ditto .... in tons...	4060·6	3407·7	2780·94	2561·1	2356·5
Ditto to the outside of plank, in tons; or the total displacement........................	4263·6	3578·0	2924·9	2689·17	2474·3
Length on the construction water-line $= l = 5{\cdot}1845\ D^{\cdot 3088}$ ...	201·46	190·81	180·66	174·73	170·25
Addition on the ends $= \frac{l}{83} = f$ ...	2·42	2·29	2·17	2·1	2·04
Of this is added forward $\frac{7}{10} f$	1·69	1·6	1·52	1·47	1·42
Ditto Ditto abaft $\frac{3}{10} f$ ...	·73	·69	·65	·63	·62
Length of the ship, measured on the line of floatation between the rabbets = L	203·88	193·10	182·83	176·83	172·29
Main breadth on water-line for three-deckers .... $l\ \frac{0{\cdot}9947}{3{\cdot}5734}$; Do. for ships of 2 decks $l\ \frac{0{\cdot}8392}{1{\cdot}5728}$ = B	54·74	51·91	49·59	48·21	47·2
Main breadth with plank on	55·5	52·61	50·25	48·9	47·9
$\frac{D}{lB} = t$	12·73	11·91	11·0	10·5	10·15
$1{\cdot}6303\ t^{0{\cdot}935} = tr$	17·56	16·49	15·34	14·69	14·15
Exponent of the parabolic curve, which expresses the areas of the transverse sections (the less it is the sharper is the ship fore and aft) $= \frac{t}{tr - t} = n$	2·56	2·52	2·47	2·44	2·42
ϕ main section area to outside of the timbers $= B\,tr = \phi$	969·26	861·79	766·51	713·63	675·21
ϕ construction depth $= 2{\cdot}37402\ tr^{\,0{\cdot}7647} = d$	21·18	20·18	18·76	18·48	18·01
ϕ depth to upper edge of rabbet of the keel $= 1{\cdot}503\ d^{\,0{\cdot}87} = q$ ...	21·33	20·43	19·5	18·95	18·53
ϕ from exponent $= \frac{\phi}{Bd - \phi} = m$ ...	4·85	4·43	4·04	3·84	3·69
Floatation half area moulded $= \frac{\overline{\frac{1}{2} BL}^{\,1{\cdot}046}}{1{\cdot}7186} = W$	4862·46	4343·41	3908·13	3665·25	3488·84
Floatation exponent $= \frac{W}{\frac{1}{2} BL - W} = r$	6·38	6·144	5·95	5·82	5·74
Moment of stability for three-deckers, in cubic feet of water, $= \frac{\overline{\frac{1}{2} B^3 L}^{\,1{\cdot}025}}{2{\cdot}9042}$; for two deckers $\frac{\overline{\frac{1}{2} B^3 L}^{\,1{\cdot}0714}}{[illegible]51} = \int \frac{2}{3} y^3 \dot{x} = p\,D$	2151103·5	1724127·0	1401902·1	125826·1	1122411·6
Distance of centre of gravity of displacement to metacentre, or $\int \frac{2 y^3 \dot{x}}{3 D} = p$	14·78	14·12	13·71	13·47	13·29

TABLE V. (*concluded.*)

Nature of the Elements.	110 Guns.	94 Guns.	80 Guns.	74 Guns.	66 Guns.
		English Feet.			
Exponent of displacem[t]. from water-line to the keel $= \frac{\frac{1}{2}D}{aW - \frac{1}{2}D} = s$	2·133	2·044	1·95	1·87	1·82
Centre of gr. of displacement from water-line $\frac{\overline{s+1}.\overline{2s+1}.s.\overline{2s+4}}{2.\overline{2s+1}.\overline{2s+4}} = g$	8·572	8·105	7·598	7·308	7·091
Metacentre above water-line $p-g = s$	6·43	6·22	6·31	6·35	6·39
Common centre of gravity of ship above water-line $= v$	2·73	2·32	2·16	2·17	2·18
Distance of metacentre above centre of gravity $= a$	3·71	3·90	4·15	4·18	4·21
To have the same stability in all these ships with the same surface of sail, a must be equal to	3·709	3·88	4.02	4·17	4·23
Centre of gravity before middle of water-line $= \frac{L}{76}$	2·68	2·54	2·4	2·32	2·26
Middle of the water-line l abaft the middle of the water-line $L = 0{\cdot}2f$	·485	·455	·436	·407	·407
Centre of gravity before the middle of the water-line $l = a$	3·14	2·987	2·83	2·73	2·66
φ section before centre of gravity $a.\overline{n+1}$	11·52	10·79	10·1	9·68	9·38
φ section before middle of water-line $l = a.\overline{n+2}$	14·12	13·33	12·5	12·0	11·64
From the abaft end of the water-line l to $\varphi = P$	114·94	108·7	102·8	99·32	96·8
Distance, for design, between the sections abaft $\varphi = \frac{P}{10}$	11·49	10·87	102·8	9·93	9·68
From the fore end of the water-line l to φ, for design, $= Q$	85·68	81·28	77·01	74·59	72·78
Space between the sections, before, $= \frac{Q}{10}$	8·56	8·12	7·7	7·45	7·27
Height of lower portsills above water	6·28	6·3	6·71	6·62	6·54
Weight of guns, shot, wads, powder, carriages, in cubic feet	21194	16882	13612	11737	10693
Ditto, in tons	607	483	390	336	306
Gunners' stores $\frac{3}{100}$ of above, to add, in cubic feet of water	635·8	506·4	408·3	352·1	320·8
Ditto, in tons	18·1	14·4	11·6	10·06	9·1
Weight of ballast in cubic feet of water	16851	13156	10332	8924	81223
Ditto, in tons	482·8	376·9	296·	255·	232·7
Number of men	1000	848	706	658	606
Weight of hull, rigging, boats, anchors, &c. or the weight of ship without guns, stores, ballast, and provisions, in cubic feet	70688·3	67907·	57390	51771	47822
Ditto, in tons	2025	1945	1644	1483	1370
Burthen of the ship, viz. guns, stores, ballast, water, and provisions, in tons	2238·6	1633	1276·9	1206·1	1104·3
Weight of ship and contents, in tons	4263·6	3578·	2920·9	2689·1	2474·

 TABLE

Table VI.

Table *of Elements for Swedish Frigates, reduced to English Measure.*

[From Chapman's Treatise on Ships of War, published in 1806.

Nature of the Elements.	44 Guns.	40 Guns.	36 Guns.	28 Guns.	26 Guns.	10 Guns.
No. of guns: Main deck, Sw. calib.	26–30 Prs	26–24 Prs	24–18 Prs	22–12 Prs	20–12 Prs	10–4 Prs
Do. in Engl. calibre	Engl. 28·11	Engl. 22·19	— 16·86	— 11·24	— 11·24	— 3·75
Quarter deck, & forec.	18–12	14–8	12–6	6–4		
Do. in English calibre	— 11·24	— 7·49	—5·92	—3·75		
No. of crew	400	330	278	213	179	52
No. of months provisioned for	5	5	5	4¼	4⅓	4
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Weight of guns and ammunition at 60 shot per gun	166·15	127·63	88·75	52·89	39·01	7·69
Weight of crew with effects	42·38	34·96	29·45	22·56	18·96	5·51
Provisions, casks, wood for five months, and water & casks for half the time	252·51	208·3	175·5	127·9	97·9	26·5
Ballast, in tons	149·64	123·13	99·48	66·	53·8	19·8
Weight of ordnance and stores, crew and effects, provisions, water, wood, casks, and ballast......	610·68	494·02	393·18	269·35	209·67	59·50
Weight of hull, in tons.....	749·07	605·94	482·2	330·1	257·1	72·57
Roundhouse, boats, &c. cordage to tackling, sails, anchors, rope, cables, blocks, dead-eyes, masters' and carpenters' stores, in tons	170·32	141·59	116·06	83·43	67·14	22·3
Total displacement to outside of timber, in tons..	1530·07	1241·5	991·44	682·88	533·91	154·37
Weight of plank	76·5	62·7	49·5	34·14	26·69	7·71
Displacement to outside of plank, allowing the plank to be 1/20 of displacement	1606·57	1304·2	1040·9	717·02	560·6	162·08
Length of water-line, in feet	160·1	149·5	138·9	122·9	113·5	73·2
Moulded breadth of water-line	41·63	39·41	37·15	33·68	31·57	22·77
Depth of φ to upper side of keel	16·38	15·29	14·2	12·55	11·58	7·68
Height of lower portsill above water	8·44	8·11	7·55	6·82	6·16	4·38
Area of φ in square feet without plank	489·38	426·57	367·9	287·8	244·9	108·1
Area of floatation witht plank	5593·59	4910·9	4269·7	3404·6	2905·6	1346·46
Height of metacentre above centre of gravity of displacement	12·56	12·12	11·86	10·96	10·51	8·55
Centre of grav. of displacement below water-sectn.	5·79	5·37	4·96	4·33	3·91	2·53
Cent. of grav. above floatation	2·34	2·24	2·07	1·83	1·69	1·12
Metacentre above floatation	6·77	6·75	6·9	6·63	6·60	6·04
Do. above centre of gravity	4·43	4·51	4·83	4·8	4·9	4·92
Excess of draught of water abaft over that forward	1·73	1·65	1·58	1·46	1·38	1·06

XVI. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. Children, *F.R.S. L. & E. F.L.S. &c.*

[Continued from p. 16.]

Genus 60. APAMEA, *Ochs., Treitsch.*
(Stephens*.)
(Curtis.)

Wings, deflexed during repose; anterior elongate triangular, obtuse, the apex in some species slightly acuminated.

Antennæ very slender, pubescent beneath, pilose in the males.

Palpi moderate, subclavate, the basal joints clothed with elongate broad scales, the terminal exposed, obtuse, not so long as the basal, very slender, compressed, the apex obtuse, the intermediate joint as long again as the first, slightly bent and somewhat acute at each extremity, basal joint a little curved, rather slender at the base: *maxillæ* as long as the antennæ.

Head

* The recent publication of the 27th and 28th Numbers of Mr. Stephens's "Illustrations of British Entomology," enables us to make some useful additions to the genera we gave last month; and first we shall supply the miserable deficiency of Treitschke's generic characters of Hadena, by copying those given by Stephens at p. 179 of the second volume of his "Haustellata."

"*Palpi* short, rather slender, slightly ascending, clothed with hair and scales, triarticulate; terminal joint rather exposed, short, subovate: the basal joint curved, in general rather shorter and stouter than the second, which is a little attenuated towards the apex; terminal subovate, obliquely truncate: *maxillæ* about the length of the antennæ. *Antennæ* short, rather stout, in general simple, with the under side ciliated in the males, or obscurely subserrate, with a distinct fasciculus of hair on each joint within: *head* small, with a dense frontal crest; *eyes* large, globose, sometimes pubescent: *thorax* slightly crested: *body* stout, rather elongate, very acute in some females: *wings* slightly deflexed during repose; anterior obscurely denticulate on the hinder margin: in general of gay colours, sometimes with pale reticulations, and mostly with a pale undulated striga, in which is usually a conspicuous angulation, resembling the letter W, near the posterior margin; stigmata distinct; posterior wings with an obscure emargination towards the costæ: *larva* naked, generally of lively colour: *pupa* subterranean."—

Euplexia, Steph.

Of the fourth species of Treitschke's fifty-sixth genus, *Phlogophora lucipara* (*Noctua lucipara*, Linn.), Stephens has made a new genus by the name of Euplexia, to which he assigns the following characters.

Euplexia.

"*Palpi* moderate, subclavate, clothed with elongate scales, the terminal joint exposed, obtuse, rather slender; basal joint slightly curved, rather longer than the third, which is somewhat attenuated and acute; the second as long again as the third, and gradually attenuated to the apex, which is obliquely truncate: *maxillæ* long. *Antennæ* stout, elongate,

Head with a dense fascicle of scales on the crown: *eyes* globose, naked: *thorax* subquadrate, slightly crested, the crest anteriorly

gate, closely ciliated in the males, with a few short bristles in the females: *head* small, with a dense frontal crest: *eyes* naked: *thorax* stout, subquadrate, with a double crest posteriorly: *abdomen* moderate, carinated, and crested on the back, the crest on the third segment very long and conspicuous, the terminal segment in the males broad, semicircular, and fringed with long fascicles of hair; in the females somewhat triangular, and but slightly fringed: *wings* short, entire, deflexed, and longitudinally wrinkled during repose: *cilia* emarginate: *stigmata* very large. *Caterpillar* naked, smooth: *pupa* subterranean."—*Steph. Illust. Brit. Ent. Haust.* III. 3.

Stephens mentions only one species of Euplexia.

TRACHEA, Ochs. (Genus 59.)

"*Palpi* moderate, the basal joint pubescent, the second densely clothed with scales, the terminal minute, exposed, ovate; basal joint stouter and shorter than the second, a little bent; second stoutest at the base, rather attenuated at the apex; terminal one-third as long as the second, rather slender, ovate; *maxillæ* elongate. *Antennæ* simple in both sexes, pubescent beneath and ciliated in the males: *head* with a dense frontal crest, produced into a tuft at the base of each antennæ: *eyes* globose, naked: *thorax* stout, quadrate, crested anteriorly and posteriorly: *abdomen* elongate, carinated and crested on the back in both sexes; male with a small anal tuft: *wings* deflexed during repose, anterior elongate-triangular, the posterior margin faintly denticulated; posterior ovate-triangular. *Caterpillar* naked, smooth: *pupa* subterranean."—*Steph. l. c.* p. 21.

The only species which Stephens enumerates as of this genus is *Noct. atriplicis*, Linn., the first in Treitschke's catalogue, and constituting his Family A. —For Treitschke's three remaining species, viz. *Præcox*, of his Fam. B., and *Porphyrea*, and *Piniperda*, Fam. C., Stephens has adopted as many distinct genera, ACTEBIA, SCOTOPHILA, and ACHATIA, with the following characters assigned them respectively.

ACTEBIA [a], Stephens.

"*Palpi* short, robust, porrected obliquely, densely clothed with compact scales; the terminal joint exposed, subrhombic; the two basal joints nearly of equal length and stoutness, the first curved, the second shuttle-shaped, the terminal slender, elongate-ovate: *maxillæ* elongate. *Antennæ* elongate, slender, pubescent beneath, ciliated on each side in the males; the basal joint large and squamose: *head* small, with a dense frontal crest: *eyes* large, globose, naked: *thorax* slightly crested posteriorly: *abdomen* elongate, somewhat depressed, a little pubescent at the base, slightly carinated in the males, with a small anal tuft; stouter in the females: *wings* deflexed during repose; *anterior* very narrow, linear, entire, glossy; *posterior* ovate-triangular, entire. *Caterpillar* naked, smooth: *pupa* subterranean."—*Steph. l. c.* p. 20.

Only one species.

SCOTOPHILA [b], Stephens.

"*Palpi* rather distant, porrected obliquely, slender at the base, subclavate, the two basal joints clothed with rather elongate scales, the apical minute, exposed, somewhat acute; the basal joint about two-thirds the length

[a] Ακτη *littus*; βιοω *vivo*.

[b] Σκοτος *tenebræ*, φιλεω *amo*.

anteriorly and posteriorly bifid: *abdomen* moderate, scarcely tufted on the back and sides, the apex with a small tuft, obtuse in the males, acute in the females.

Larva naked; *pupa* subterranean*.

Ochsenheimer, or rather Treitschke, has divided this genus into four families.

FAM. A.—With a very bright white or yellow reniform spot on the fore-wings.

FAM. B.—Small species (N. Pusillæ, Fam. V. Wien. Verz.), with bright metallic markings on the fore-wings.

FAM. C.—Larger, generally dark coloured, species, with the fore-wings long, and rounded at the extremities.

FAM. D.—Colour inclining to copper-red, with the fore-wings shorter, and pointed at the extremities.

FAM. A. Species.	Icon.
1. Ap. *Nictitans*, Linn.	Ernst, VI. Pl. CCLVII. f. 394. a. b.
2. — *Didyma*, Borkh.	Ernst, VI. Pl. CCLVI. fig. 390 & 392. & Pl. CCLVII. f. 393.
3. — *Ophiogramma*, Hüb.	Ernst, VIII. Pl. CCCVI. f. 529.
FAM. B.	
4. Ap. *Furuncula*, Hübn.	Hübn. Noct. Tab. 117. fig. 545. (mas.)
5. — *Captiuncula*, Treit.†	— — —

length of the second, stout, reniform, the second more slender, rather tumid at the base, the apex attenuated and truncate; terminal subovate, obtuse: *maxillæ* elongate. *Antennæ* long, pubescent beneath, stout, subserrate, and slightly pectinated in the males; slender and simple in the females: *head* small: *eyes* globose, naked: *thorax* subquadrate, not crested: *abdomen* moderate, rather depressed, acute at the tip in the females, with a tuft in the males: *wings* entire, deflexed; the *anterior* narrow; *posterior* rather large. *Caterpillar* naked: *pupa* subterranean."—*Steph. l. c.* p. 18.

Only one species.

ACHATIA, Hübn.

"*Palpi* very short, nearly concealed by long hairs, the terminal joint not visible; the two basal joints robust, the first as long again, and stouter than the second, slightly curved, second attenuated, the apex truncate, third minute, cylindric, truncate: *maxillæ* elongate. *Antennæ* rather long, slender, and simple in the females, subserrated, and rather robust in the males, pubescent beneath: *head* minute, scarcely visible from above: *eyes* small, naked: *thorax* large, downy: *wings* deflexed during repose; *anterior* entire, obtuse: *abdomen* short, rather stout, pubescent on the sides, and at the apex. *Caterpillar* naked, smooth: *pupa* subterranean."—*Steph. l. c.* p. 19.

Only one species.

* Characters from Stephens. *Haust.* III. p. 6.

† Ap. alis anticis fuscis, fasciâ mediâ obscuriore, stigmate reniformi fasciâque externâ albidis.—*Ochs. Treitsch.* V. *pars* II. 96.

6. Ap. *Suf-*

Species.	Icon.
6. Ap. *Suffuruncula*, Treit.*	
7. — *Latruncula*, Hübn.†	Ernst, VIII. Pl. CCCXIV. f. 548.
8. — *Strigilis*, Linn.‡...	Ernst, VIII. Pl. CCCXV. f. 551.
FAM. C.	
9. Ap. *Connexa*, Borkh.§	Ernst, VI. Pl. CCXXXIX. f. 351.
10. — *Testacea*, Hübn.§	Ernst, VII. Pl. CCLXXVII. f. 451.
11. — *Basilinea*; Fab.§	Ernst, VII. Pl. CCLXIII. f. 414.

12. Ap.

* Ap. alis anticis fuscis, cupreo argenteoque splendentibus, macula in medio quadrata nigra.—*Ochs. Treitsch.* V. *pars* II. 97.

† MIANA, Steph.

"*Palpi* short, porrected obliquely, the two basal joints sparingly clothed with elongate scales, the terminal one exposed, somewhat acute, and placed obliquely, very slender when denuded; the basal joint short, stouter than the following, which is slightly curved, attenuated towards the apex, and nearly three times as long as the basal; terminal elongate-ovate, nearly as stout as the second, and about the length of the basal: *maxillæ* elongate. *Antennæ* short, finely ciliated and pubescent in the males, simple in the females: *head* with a frontal crest: *eyes* naked: *thorax* subquadrate, with a posterior dorsal crest: *abdomen* slender, with a small tuft at the apex in the males, and a little crested on the back: *wings* entire, deflexed, anterior elongate triangular, with indistinct, nearly concolorous stigmata. *Caterpillar* naked: *pupa* subterranean."—*Steph. Illust. Brit. Ent. Haust.* III. p. 11.

Stephens adds, that the species of this genus are distinguished from the Apameæ, by their small size, nearly concolorous posterior stigmata on the anterior wings, the smallness of their palpi, slenderness of body, and by the thorax not being anteriorly crested.

‡ MIANA, Steph.—Next to his genus Miana, Stephens has introduced another new Genus, CELÆNA, founded on four species, viz. Ce. *renigera*, Steph. (of which only three specimens are known); Ap. *Haworthii*, Curtis, VI. pl. 260;—Noct. *hibernica*, Haw. MSS. (a Dublin species); and, with a mark of doubt, No. *lancea*, Esper. The characters of this genus are,

CELÆNA, Steph.

"*Palpi* not very short, porrected obliquely, the two basal joints densely clothed with elongate scales, the terminal exposed, rather obtuse, sublinear: basal joint short, reniform, scarcely stouter than the second, which is nearly linear, a little curved and slightly acute; terminal stouter than the first, elongate-ovate, obtuse: *maxillæ* elongate. *Antennæ* moderate, rather stout, pubescent beneath, and ciliated in the males: *head* with a dense tuft of scales on the crown: *eyes* naked: *thorax* large, somewhat downy, not crested: *body* rather short and slender, the sides and apex tufted, the apical tuft largest in the males: *wings* deflexed, entire; *anterior* elongate-triangular, obtuse; stigmata, especially the posterior, conspicuous, not concolorous."—*Steph. Illust. Brit. Ent.* III. p. 15.

The Celænæ are nearly of the same size as the Mianæ, but are distinguished from them by their broader anterior wings, with very conspicuous posterior stigmata, and the adjoining nervures generally pale; the palpi are more densely scaly, and the terminal joint somewhat linear and obtuse, not subacuminate; the thorax is stout, and not crested.

§ HAMA, Steph.

"*Palpi* short, subclavate, the basal joint clothed with elongate scales, the terminal exposed and conic, about as long as the first, subovate, com

pressed,

Species.	Icon.
12. Ap. *Infesta*, Treitsch.	Ernst, VII. Pl. CCLXXXIX. f. 484. b.
13. — *Cespitis*, Fab.* ...	Ernst, VII. Pl. CCLXXX. f. 459.
FAM. D.	
14. Ap. *Leucographa*, Hüb.†	Hübn. Noct. Tab. 88. f. 411. (mas.) Tab. 124. f. 572. (mas.)
15. — *Bella*, Borkh......	Hübn. Noct. Tab. 101. f. 477. (mas.)
16. — *Umbrosa*, Hübn.†	Hübn. Noct. Tab. 97. f. 456. (mas.) f. 457. (fœm.)
17. — *Cuprea*, Hübn....	Hübn. Noct. Tab. 13. f. 62. (fœm.)
18. — *Conflua*, Treitsch.‡	
19. — *Haworthii*, Curtis.	Curtis, Brit. Ent. pl. 260.

Genus 61. MAMESTRA, *Ochs.*, *Treitsch.* (Stephens.)

Wings slightly deflexed during repose, *anterior* obscurely denticulated on their hinder margin, *posterior* simple.

Legs short, stout; *femora* and *tibiæ* very pilose interiorly; tibial spurs moderate.

Palpi short, triarticulate, densely clothed with elongate scales

pressed, acute; the first short, rather bent, the second stout at the base, considerably attenuated at the apex: *maxillæ* scarcely as long as the antennæ. *Antennæ* moderate, rather stout, ciliated in the males, and sometimes subserrate, pubescent beneath, with a few bristles in the females: *head* small, densely pubescent in the forehead: *eyes* large, globose, naked: *thorax* stout, woolly, subquadrate, scarcely crested: *wings* deflexed during repose, not folded; *anterior* rather long, emarginate on the posterior edge; *cilia* nearly entire: *body* moderate, carinated, and sometimes with some short fascicles of scales on the back; the sides and apex tufted in the males, scarcely so in the females. *Caterpillar* naked: *pupa* subterranean."—*Steph. Illust. Brit. Ent.* III. 4.

* CHARÆAS, Steph.

† LYTÆA, Steph.

" *Palpi* slightly ascending, triarticulate, the two basal joints densely clothed with elongate, loose depending clavate scales, the terminal almost naked; the two basal joints of nearly equal length, the first slightly curved and very robust, the second more slender, gradually attenuated from the base to the apex; the terminal minute, ovate obtuse: *maxillæ* elongate. *Antennæ* rather long, serrated internally in the males, and ciliated; simple in the females: *head* and *thorax* downy, the latter stout and not crested: *body* rather short, slender, very downy at the base, slender posteriorly and tufted at the apex, and on the sides: *wings* horizontal, entire, very glossy; *anterior* considerably rounded at the base; *posterior* scarcely emarginate on the hinder margin; with a dark fimbria, and a more or less distinct transverse dusky striga, with a central spot of similar hue. *Larva* radicivorous; *pupa* subterranean."—*Steph. Illust. Brit. Ent.* II. 107, and 199.

‡ Ap. alis anticis hepaticis, maculis ordinariis pallidioribus, strigis obsoletis confluentibus.—*Ochs. Treitsch.* VI. *pars* I. p. 405.

at

at the base, the terminal joint not very distinctly exposed; the basal joint the length of the terminal, subconic; the following as long again, more slender than the basal, subcylindric, a little bent, and slightly attenuated at the tip, which is obliquely truncate; terminal elongate-ovate: *maxillæ* rather long.

Antennæ elongate, rather slender, simple in both sexes, each joint producing a short bristle on each side, ciliated beneath in the males.

Head rather small, forehead densely crested: *eyes* rather large, globose, pubescent.

Thorax subquadrate, with a bifid dorsal crest.

Abdomen moderate, crested on the back, the apex with a small tuft.

Larva naked, varied.

Pupa subterranean.*

Species.	Icon.
1. Mam. *Pisi*, Linn.......	Ernst, VI. Pl. CCLXXXVII. f. 477.
2. — *Splendens*, Hubn.	Hübn. Noct. Tab. 85. f. 400. (fœm.)
3. — *Oleracea*, Linn....	Ernst, VII. Pl. CCLXXXVIII. f. 479.
4. — *Suasa*, Hübn......	Ernst, VII. Pl. CCLXXXVII. f. 478.
5. — *Aliena*, Hübn.†...	Hübn. Noct. Tab. 94. f. 441.
6. — *Nigricans*, Vieweg.	Hübn. Noct. Tab. 116. f. 539. (fœm.)
7. — *Chenopodii*, Fab.	Hübn. Noct. Tab. 18. f. 86. (mas.)
8. — *Albicolon*, Hübn.	Hübn. Noct. Tab. 117. f. 542. (mas.)
9. — *Brassicæ*, Linn....	Ernst, VII. Pl. CCLXXIX. f. 456.
10. — *Furva*, Hübn.	Ernst, VII. Pl. CCLXXXVI. f. 474. c.
11. — *Persicariæ*, Linn.	Ernst, VI. Pl. CCXXXII. f. 335.
12. — *Rubrirena*‡, Treitsch.	— — —

Genus 62. THYATIRA, *Ochs. Treitsch.* (Curtis.)

Legs, anterior; *tibiæ* with a compressed spine on the inside; middle and posterior *tibiæ* with a pair of spurs at their apex, one very small, the posterior pair with also two spurs below the middle.

Wings, deflexed, *superior* slightly hooked at the posterior angle; *inferior* large.

Antennæ, alike in both sexes, rather short, clothed with scales above, with short hairs beneath.

* Characters from Stephens.—*Haust.* II. 191.

† Hama. Steph.—*Haust.* III. 4.

‡ Mam. alis anticis nigris, maculis strigisque ordinariis rubescentibus; posticis nigro-griseis.—*Ochs.*, *Treitsch.* V. *pars* II. p. 159.

Palpi

Palpi, porrected obliquely, distant, triarticulate, longer than the head, covered with long hairy scales, the terminal joint clothed with short, close scales only; first joint short, second long, attenuated, third as long as the first, slender, conical: *maxillæ* as long as the antennæ.

Head, transverse.

Thorax clothed with long, light scales, forming a transverse crest.

Abdomen rather long and slender, with a small tuft of scales on the back near the base.

Larva, with six pectoral, eight abdominal, and two anal feet*.

Species.	Icon.
1. Thy. *Batis*, Linn......	Ernst, VI. Pl. CCXXXI. f. 333. Curtis, Brit. Ent. II. pl. 72. Imago et larva.
2. — *Derasa*, Linn. ...	Ernst, VIII. Pl.CCCVII. f. 530.

Genus 63. CALPE†, *Ochs.*, *Treitsch.*

CALYPTRA, Ochs.

Wings deflexed and crossing over one another, when at rest; the usual reniform markings and maculæ, indistinct, but the transverse bands well defined.

Antennæ, strongly pectinated in the male.

Species.	Icon.
1. Calp. *Thalictri*, Hübn.	Ernst, Suppl. Pl. VIII. f. 258. a. b. c.
2. — *Libatrix*, Linn....	Ernst, V. Pl. CXCV. f. 258.

Genus 64. MYTHIMNA, *Ochs.*, *Treitsch.* (Stephens.)

Legs, moderate: *femora* and *tibiæ* stout, and densely pilose in the males.

Wings, slightly deflexed; *anterior* entire, acute at the apex, with the stigmata nearly or quite obliterated; *posterior* obsoletely emarginate on the hinder margin.

Antennæ moderate, shortest in the females; finely ciliated in both sexes, stoutest, and somewhat pubescent beneath in the males.

Palpi short, ascending, densely enveloped in scales, the apical joint not exposed; triarticulate, the basal joint scarcely one-third as long as the second, bent; the second very long, slightly attenuated towards the apex, not so stout as the first, a little curved; terminal small, elongate-ovate, subacuminate, conic: *maxillæ* as long as the antennæ.

* Characters from Curtis, *Brit. Ent.* II. pl. 72.

† Καλπη, *Calpe*, an urn; from the peculiar hollows of the fore-wings.

Head small, with a tuft of scales: *eyes* large, pubescent.
Thorax slightly crested anteriorly.
Abdomen elongate, densely tufted at the apex, and laterally in the males; somewhat obtuse in the females.
Larva naked, with longitudinal streaks.
Pupa subterranean*.

The genus is divided by Treitschke into three families, according to the markings on the wings.

Fam. A. Species.	Icon.
1. Myth. *Oxalina*, Hübn.	Hübn. Noct. Tab. 45. f. 219. (mas.)
2. — *Acetosellæ*, Fab....	Hübn. Noct. Tab. 45. f. 220. (mas.)
Fam. B.	
3. Myth. *Turca*, Linn....	Ernst, VII. Pl. CCXCIV. f. 497.
4. — *Lithargyria*, Hübn.	Ernst, VII. Pl. CCXCV. f. 499.
5. — *Albipuncta*, Fab...	Ernst, VII. Pl. CCXCIV. f. 498.
6. — *Conigera*, Fab. ...	Ernst, VII. Pl. CCXCI. f. 492.
7. — *Imbecilla*, Fab. ...	Hübn. Noct. Tab. 120. f. 555. (mas.)
8. — *Nexa*, Hübn.......	Hübn. Noct. Tab. 84. f. 395. (mas.)
Fam. C.	
9. Myth. *Xanthographa*, Fab.†	Ernst, VII. Pl. CCLXVIII. f. 429.
10. — *Neglecta*, Hübn.† ..	Ernst, VII. Pl. CCLIX. f. 401.

Genus 65. ORTHOSIA, *Ochs.*, *Treitsch.* (Stephens, Curtis).

Legs moderate.
Wings slightly deflexed, entire; *anterior* elongate, the apex slightly rounded or somewhat acute; *posterior* short, ovate-triangular.
Palpi nearly horizontal, densely clothed with elongate scales, the terminal joint scarcely projecting; triarticulate, basal joint a little bent, above half the length of the second, and more robust, second nearly straight, terminal about the length of the basal, obscurely pear-shaped: *maxillæ* shorter than the antennæ.

* Characters from Stephens.—*Haust.* II. 149.

† Segetia, Steph.

"*Palpi* slightly ascending, densely clothed with squamose hair; the terminal joint exposed, triarticulate; the basal joint reniform, stouter than the following; the second as long again as the first, a little attenuated towards the apex; terminal minute, ovate, obtuse; *maxillæ* about the length of the antennæ. *Antennæ* moderate, stout and ciliated in the males, slender and simple in the females: *head* small: *eyes* naked: *thorax* stout, woolly, not crested: *wings* slightly deflexed, short; *anterior* obtuse and rounded posteriorly, with distinct stigmata: *body* rather short, the male with a tuft at the apex; the female with the apex acute: *legs* with the *femora* very pilose. *Larva* naked: *pupa* subterranean."—*Stephens's Illust. Brit. Ent.* II. p. 153.

Antennæ

Antennæ simple in the females; bipectinated or ciliated in the males.
Head small, with long scales above.
Thorax not crested, stout, woolly.
Abdomen short, tufted in the males, acute in the females†.

Species.	Icon.
1. Orth. *Cæcimacula*, Fab.	Ernst, VII. Pl. CCLXIV. f. 415. c—f.
2. — *Instabilis*, Fab.....	Ernst, VII. Pl. CCLXIII. f. 414. d—h.
3. — *Munda*, Fab.......	Ernst, VII. Pl. CCLVIII. f. 396.
4. — *Ypsilon*, Hübn....	Hübn. Noct. Tab. 29. f. 136. (mas.)
(4*. — *Lanosa*, Haworth,	Curtis, Brit. Ent. Pl. 237.)
5. — *Lota*, Linn........	Ernst, VII. Pl. CCLIX. f. 400.
6. — *Macilenta*, Hübn.	Ernst, VII. Pl. CCLXI. f. 409.
7. — *Gracilis*, Fab......	Ernst, VII. Pl. CCLXIII. f. 414. a—c.
8. — *Opinia*, Hübn. ...	Hübn. Noct. Tab. 90. f. 424. (mas.)
9. — *Populeti*, Fab......	Ernst, VII. Pl. CCLXII. f. 412. b.
10. — *Stabilis*, Hübn. ...	Ernst, VII. Pl. CCLXII. f. 412. c. d.
11. — *Carnea*, Thunb...	Hübn. Noct. Tab. 81. f. 377. (fœm.)
12. — *Miniosa*, Fab.....	Ernst, VII. Pl. CCLXII. f. 411.
13. — *Cruda*, Götze.....	Ernst, VII. Pl. CCLXII. f. 413.
14. — *Lævis*, Hübn......	Hübn. Noct. Tab. 34. f. 163. (fœm.)
15. — *Nitida*, Fab.	Hübn. Noct. Tab. 38. f. 180. (fœm.)
16. — *Humilis*, Fab......	Ernst, VII. Pl. CCXCIX. f. 508. c.
17. — *Pistacina*, Fab....	Ernst, VII. Pl. CCLVIII. f. 397.
18. — *Litura*, Linn.......	Ernst, VII. Pl. CCLVIII. f. 399. a. b.

[To be continued.]

XVII. *A Description of the Subgenus* Epiphyllum. *By* A. H. Haworth, *Esq. F.L.S. &c.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

HAVING just examined a new and specious plant of the subgenus *Epiphyllum* of the *Cactæan* order, at Mr. Tate's choice Nursery, in Sloane-street (where so many new tropical plants are found), I send you hereunder a full description of it. And in order to make the communication a little more acceptable to your botanical readers, I have added to it a monographical sketch of all the other species of *Epiphyllum*, with new sections and characters to elucidate the whole, as far as known to me, which are seven in number. The new species is named

† Characters from Stephens's *Illust. Brit. Ent. Haust.* II. p. 139.

Ackermanni, in compliment to the son of Mr. Ackermann in the Strand, London, its meritorious introducer into this country.

I remain, &c. your old correspondent,

A. H. HAWORTH.

Classis et Ordo. ICOSANDRIA MONOGYNIA.

Ordo Nat. CACTEÆ, *DeCandolle Prod. Syst. Veg.* 3. 457.
CACTI, *Juss. &c.*

Genus EPIPHYLLUM.—*Herman, Par. Bat. add.*—*Nob. Synops. Succ.* 197.—*Neck. elan.* 1. p. 85. (ex *DeCand.*)

SUBGENERIS CHARACTER.

Corollæ tubus longissimus, mediocris vel brevissimus, sparsìm et remotè squamulosus inermis, e crenis ramulorum oriens, inter perpusillas et innocuas spinulas: limbus (corollæ fugacis) altè multifidus vel quasi polypetaloideus rosaceus, aut subindè plùs minùs elegantissimè ringens.

Suffrutices Americæ calidioris ramosi graciles, sed vix scandentes, in scopulis rupibusve; vel insuper arborum truncos; ramulis alatim compressissimis, tenuibus sed carnosulis, lobato-crenatis, viridibus lævibus, axe centrali gracili ligneo.

Flores solitarii sæpiùs magni speciosi, albi, rosei, coccineive, rariùs suaveolentes.

Obs. Radicem versus ramuli incipientes subindè pullulant angulati, qui denique, semper fortasse, sursum gradatim alati evadunt. *Cereorum* cætera, et etiamsi genus vel subgenus absque artificiali charactere, verè naturale est.

* NOCTURNA, corollis fugacibus suaveolentibus albis, noctu solùm aperientibus tubo longissimo.

SPECIERUM CHARACTERES.

Phyllanthus. E. (The long-tubed night-flowering) corollâ parvâ
1. tubo ferè pedali multoties longiore, stigmatibus decem.

Epiphyllum Phyllanthus. *Nob. in Synops. Succ.* 197. excluso synon. *Pluk.* quod ad *E. phyllanthoidem* meliùs pertinet.

Cactus Phyllanthus, *Linn. Sp. Pl.* 1. 670. *DeCand. Plant. Grasses*, t. 145.

Cereus Scolopendrifolio, &c. *Dill. Elth.* t. 64. f. 74.

Habitat in America Meridionali.

Hookeri. E. (The lesser-tubed-night flowering) corollâ me-
2. diocri tubo subsemipedali, duplò longiore, stigmatibus subtredecim.

Cactus Phyllanthus, *Hook. in Bot. Mag.* 2692.

Obs. Flores non vidi. Hookeri figura solùm examinavi.

Habitat ......

** DIURNA,

** Diurna, corollis inodoris per dies noctesque constanter apertis, tubo mediocri vel brevissimo.

Phyllanthoides. E. (Rosy-flowered) corollâ magnâ rosaceâ,
3. tubo mediocri, petalis oblongo-lanceolatis breviore: stigmatibus septem.

Cactus phyllanthoides. *DeCand. Prod. Syst. Veg.* 3. 469.—*Bot. Mag.* 2092.

Cactus speciosus. *B. Reg.* 304.

Epiphyllum speciosum. *Nob. Suppl. Pl. Succ. p.* 84.

oxypetalum. E. (Acute, red and white flowered) tubo longi-
4. tudine loborum acuminatorum; floribus sessilibus, fructibus longitudinaliter nervato-angulatis.

Cactus oxypetalus. *DeCand. Prod. Syst. Veg.* 3. 470.

Habitat in Mexico. ♄.

Flores 4-pollicares longi, extùs fusco-rubentes, intùs albidi. *Bacca* rubra oblonga, costata, utrinque attenuata. *Rami* C. phyllanthoidis, *DeCand. l. c.*

Non vidi, neque figuram.

alatum. E. (small green-white-flowered) corollâ parvâ viridi-
5. albâ, tubo brevissimo, baccâ nigricante.

Cactus alatus. *DeCand. Prod. Syst. Veg.* 3. 470.

Epiphyllum alatum. *Nob. Suppl. Pl. Succ.* 84.

Habitat in Jamaica calidiore.

Flores apertos non vidi. Descriptio ex *DeCand. l. c.*

Ackermanni. E. (Ackermann's large scarlet-flowered) corollâ
6. maximâ obsoletissimè ringente ante florescentiam assurgente, apice acuto; quàm tubo ferè quadruplò longiore.

Habitat in Mexico, ubi invenit Dom. Ackermann, et Domino Tate multis aliis communicavit: in cujus horto nunc copiosè floret. ♄.

Obs. Antecedenti fortasse nimis affinis. Facies *E. phyllanthoidis*, at ramorum lobi pauciores, obtusiores, et ferè auriculiformes: et in eorum axillis spinulis ordinariis fortè conspicuioribus. *Flores* solitarii sed numerosi, et affinium more, directione ferè horizontali, *tubo* cum germine plusquam unciali, sordidè viridi, et quasi 5-angulari e decursione squamularum paucarum seu remotarum et calycinarum. *Petala* imbricata acuminata nitentia, inferiora longè minora, canaliculatim carinata, apice recurvula: summa (*petala*) quasi biserialia semiexpansa lanceolata coccinea, horum cœlum versus oblonga et lanceolata, et cætera terram spectantia oblonga et angustiora. *Genitalia* ut in affinibus, corollâ breviora, declinata rosea, sed apicem versus eleganter

ganter curvatim adscendentia, *stylo* humiliora, stigmatibus circiter septem.

Obs. Petala extus lineâ costali paululum protuberantia, aurorâ pulchrâ colore nitentia. *Antheræ* et *stigmata* tincturâ formosâ roseo-mutabiliter violascente.

truncatum. E. (The reflexing ringent flowered) corollis re-
7. flexis valdè ringentibus, tubo brevissimo, ramulis dichotomis apice truncatis.

Epiphyllum truncatum. *Nob. Suppl. Pl. Succ.* 85. et in *Phil. Mag.* vol. 4. p. 188.

Cactus truncatus. *Bot. Mag.* 696.

Habitat in Brasiliâ. ♄.

Floret autumno in caldario.

P.S. Please to note the following errata in my last communication:—

Page 262, line 8, *for* subdistantibus, *read* subdistantes.
—— 264, line 22, *for* polyphyllum, *read* polyanthum.

XVIII. *Notice of the Arrival of some of the Winter Birds of Passage, as well as of a few of the occasional Visitants in the Neighbourhood of Carlisle, during the Winter of* 1828—1829; *with Observations, &c. By* A Correspondent.

No.	English Specific Names.	Latin Specific Names.	When first observed.
1	Redwing Thrush	Turdus iliacus........	Oct. 12
2	Fieldfare Thrush	——— pilaris........	—— 19
3	Snow Bunting...	Emberiza nivalis......	Nov. 9
4	Mountain Finch	Fringilla montefringilla	Oct. 24
5	Siskin.............	——— spinus.........	—— 26
6	Green Sandpiper	Totanus ochropus......	July 21
7	Woodcock..	Scolopax rusticola......	Aug. 26

Rough-legged Buzzard (Buteo Lagopus).—A very fine specimen of this rare Buzzard was killed in the neighbourhood of Bewcastle the latter end of February, where another was seen. This is only the second instance of this species having been captured in this part of the county: the other was shot near Wreay in November 1824.

Cinereous Shrike (Lanius excubitor).—For the last five or six years the Cinereous Shrike has visited this neighbourhood pretty regularly, scarcely a winter passing without one or more having been either seen or obtained. Its arrival, however, is apparently

apparently very irregular, as it has occurred during the above period in almost every month from October to April. On the eleventh of April 1828, I saw one near Stainton; and on the seventh of March it was observed close to Brugh-by-Sands, and pursued nearly the whole day, but without success.

Bohemian Chatterer (Bombycilla garrula).—Several specimens of this beautiful species were killed in the month of January, two of which were brought to me. It would appear that these birds feed greedily upon the fruit of the wild briar *Rosa canina*), as well as upon the berries of the mountain ash (*Sorbus aucuparia*), the thorn (*Cratægus oxyacantha*), &c. The stomach of one was completely filled with these berries (*R. canina*), and I was somewhat surprised to find that several had been swallowed quite whole, although very large. The other had been also feeding upon the same fruit, although killed after an interval of several days and in a different part of the county. Both these birds proved to be males; yet one had but five, and the other only four waxen appendages attached to the secondary quills of each wing. Temminck, and indeed almost all writers on ornithology, state that the number of these appendages is one of the characteristics by which the sexes may be distinguished; yet I have reason to think they are a very doubtful criterion, and will in all probability eventually prove to be more indicative of age than of sex.—As the following observations upon this subject are but little known, I have been induced to extract them from Hutchinson's History of Cumberland, a work only in the possession of few individuals*. "This beautiful bird (*Bohemian Chatterer*) only visits Cumberland occasionally, and then only in the winter season. In the beginning of the year 1787 great numbers were killed in the north of England. What distinguishes this from all other birds, are horny appendages from the tips of the secondary feathers, of the colour of the very finest red sealing-wax. The females are said to be distinguished from the males by the want of the appendages and yellow marks in the wing feathers; which, however, is not the case, as will appear from the following account. One of these birds was found dead, in February 1784, near Brugh-on-the-Sands: it had six crimson appendages at the end of the secondary quills; the tips of the quill feathers rather a dirty white than yellow. I could not distinguish, upon dissection, whether it was male or female. On the eighth of February 1787, Mr. Story sent me a specimen, which was killed near Keswick: on the right wing were six of the horny appendages, on the left only five: five of the

* See Catalogue of Cumberland Animals, vol. i. page 11.

quill

quill feathers, and one of the secondaries on each, were tipped on the outer margin with a fine yellow: on dissection *this proved to be a female.* On the same day a flock of five or six of these birds were seen feeding on the fruit of the hawthorn, near Blackwell, a mile and a half from Carlisle. Two of them were shot, and sent to me; one had seven red appendages on the right wing, and six on the left; the other had six on each wing: only four of the quill feathers had yellow tips, and the yellow in both was much *paler than in the last. They both proved to be males.* On the fourteenth of February 1787, Mr. Harrison of Penrith sent me another, which was killed near Temple-Sowerby. On each wing were seven appendages, much larger than in the former. Five of the quill feathers, and one of the secondaries in each wing (as was the case of the female sent by Mr. Story), were tipped with yellow: the appendages were much larger than in the four preceding specimens, and the four nearest the body were the largest: this bird was a male. On the twenty-second of March, in the same year, I received another, which was killed at Ravensworth, and sent to me by Sir Henry Liddell, bart.; on the right wing there were eight, on the left seven appendages, which were large. The two extreme ones, viz. the nearest and furthest from the body, were the smallest. The second, third, fourth, and fifth from the body were the largest: six of the wing feathers were tipped with yellow. In this bird all the tail feathers had also horny appendages at the ends of the shafts, which however were much smaller than those in the wings. The person by whom it was sent neglected to deliver it for near three weeks, by which the intestines, &c. were become so putrid that I could not, after the most accurate examination, ascertain whether it was male or female. The red appendages and yellow tips on the wings do therefore not depend upon the sex, but most probably on the age of the bird: and the sex, I am persuaded, can only be ascertained by dissection."

I have been given to understand that a second specimen, with waxen appendages attached to the end of the tail feathers, is in the collection of A. H. Haworth, Esq. F.L.S. &c. of Chelsea, the learned author of the *Lepidoptera Britannica*, &c. &c.

Crossbill (Loxia curvirostra).—A flock of these birds were seen near Cumwhitton, the last week in November, several of which were killed. The Crossbill very rarely occurs in this part of the county, and is the only instance of its having been met with in this vicinity for very many years. From the number of specimens said to have been killed in various parts during the present winter, it must have visited the northern counties in considerable numbers.

Snow

Snow Bunting.—Small flocks of Snow Buntings, I believe, annually resort to the salt marshes below Rock Cliff. During the remarkably fine mild weather in November and December last, I saw them repeatedly there; but as the major part are usually young birds, they are seldom recognized. I have little doubt they arrived much earlier than is stated in the above table.

Mountain Finch.—Whether this bird ever breeds in the hilly districts in this county I have not been able to ascertain; yet I think there cannot be the least doubt that a few occasionally remain during the summer. I observed one on the 27th of April, near Nunery; and the late ingenious Mr. Bewick states that he has seen them on the Cumberland hills in the month of August.

Siskin.—The Siskin has hitherto been considered only as an occasional and very irregular visitant in this country by, I believe almost all writers on British ornithology. I have however reason to think that if not a periodical visitant, it at least visits some districts more frequently than is generally supposed. During the last four or five years it has been regularly observed in this neighbourhood, arriving in flocks varying in numbers from twenty to forty or more, and was seen last autumn on the 26th of October feeding upon the larch, to which tree it appears to be quite as partial as to either the alder or the birch: they continued to frequent the same district the whole winter, although annoyed and materially reduced in numbers by bird-catchers and others. On the 26th of March some males were observed in full song, and repeatedly chasing the females; so that it is possible a few may occasionally remain and breed. A few were seen on the 5th of April.

Green Sandpiper.—This pretty species has for some years past regularly resorted to a marshy piece of ground contiguous to the village of Irthington, from which locality I have received two specimens, and where they are occasionally seen during the autumnal and winter months; but always exceedingly shy and difficult to approach. I am not aware that they have been detected in any other situation in this vicinity.

Woodcock.—It is probable that the Woodcock seen on the 26th of August may have remained during the summer. One was seen a few years ago in July; they however are rarely seen in this district before the middle or latter end of October.

Wild Swan (Cygnus ferus). — Small flocks of wild Swans are seen almost every winter in Solway Frith, and generally one or two procured. On the 20th of February two were killed out of a flock of five in Brugh Marsh.

Brent Goose (Anser Brenta).—A rather singular specimen

 of

of this species was shot near Crosby-upon-Eden, on the 11th of April. The lowest part of the white patch on each side of the neck was only clearly defined: above this were a few irregular longitudinal white streaks, more numerous and distinct on the left than on the right side.

The Brent Goose is one of our rarest visitants here; whilst on the contrary the Bernacle (*A. Bernicla*) is a regular winter visitant, and occasionally seen in great numbers.

Black-throated Diver (Colymbus arcticus). — A speckled Diver was killed in the river Eden about the 7th of February, which from its weight and size* was in all probability an immature bird of this species. I could not ascertain its sex: in the stomach were three small chubs or skellys (*Leuciscus cephalus*) recently swallowed. An old Red-throated Diver (*C. septentrionalis*) was killed on the same river on the 17th of April, 1823. Both are of rare occurrence here. Dr. Fleming, in his History of British Animals, appears to think that these two species may eventually prove to be the same; the latter being the female of the former.

Carlisle, April 27, 1829.

XIX. *On the Construction and Applications of the improved Sliding-Rod Eudiometer and of the Volumescope. By* ROBERT HARE, *M.D. of Philadelphia*†.

Description of an improved Mercurial Sliding-Rod Eudiometer.

THE aqueous sliding-rod hydro-oxygen eudiometer, (see Phil. Mag. vol. lxvii. p. 21.) although perfectly well qualified for experiments in which water is employed, does not answer well when used over mercury. The great weight of this liquid causes the indications to vary during manipulation, in consequence of changes of position too slight to be avoided.

The instrument represented in fig. 1. is furnished with a water-gauge O M, which, being appealed to, enables us to cause the pressure of any contained gas to be *in equilibrio* with that of the external air, and consequently to measure it with accuracy. Excepting the gauge, the mechanism by which the measurement is effected is the same as that of the sliding-rod eudiometers for water above alluded to. However, in addition to the stuffing-box at A, there is in the mercurial eudiometers a collar of cotton wick soaked in oil, and packed by a screw B, which includes the cotton and compresses it about the rod. The object of this addition is to supply oil to the rod where it enters the collar of leather; otherwise, they would soon become so dry as to allow air or mercury to pass.

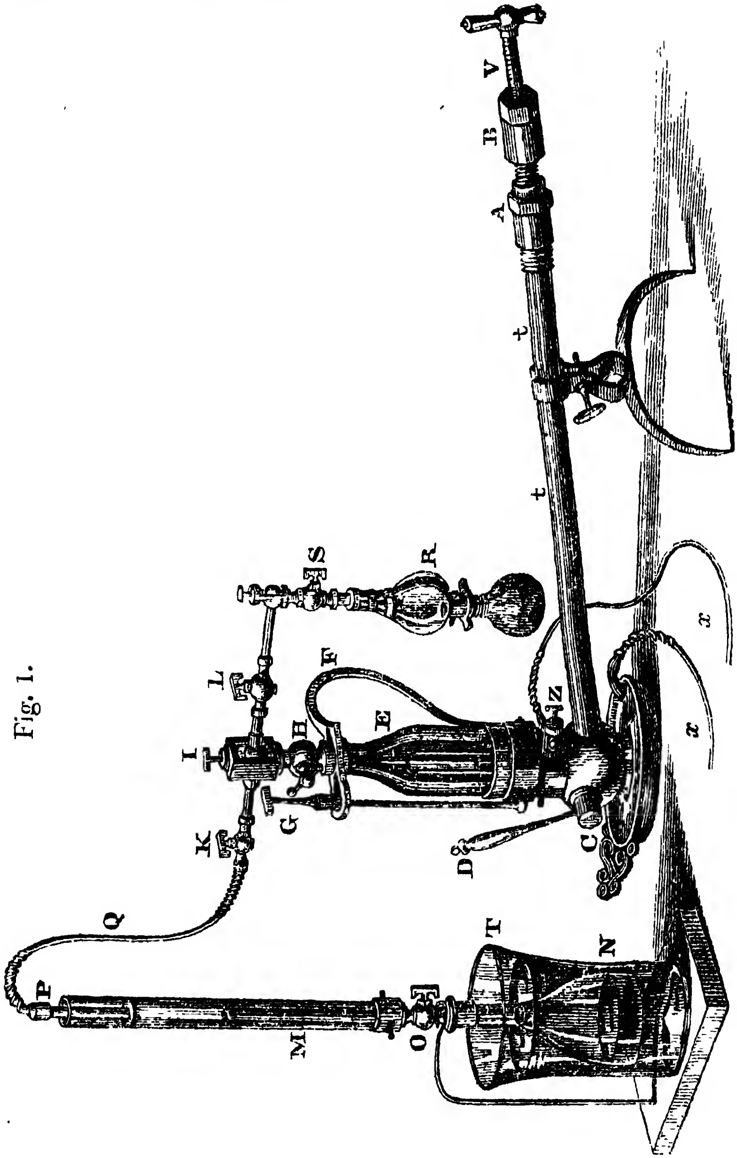
* Weight, 4 pounds 1 ounce; Length, 28 inches.

† Communicated by the Author.

Let

Let us suppose that this eudiometer has been thoroughly filled with mercury, and that it is firmly fixed in the position

Fig. 1.



in which it is represented in the figure, so that the lower part may descend about an inch below the surface of some mercury

 contained

contained in an iron cup. At C is a cock, the key of which, in addition to the perforation usual in cocks, has another at right angles to, and terminating in the ordinary perforation. When the lever D, attached to the key, is situated as it appears in the figure, the tube containing the sliding-rod communicates with the receiver, but not with the mercury in the cup. Supposing the lever moved through a quarter of a circle to the other side of the glass, the tube in which the rod slides will communicate at the same time with the receiver E and the mercury. F is a steel spring, which has a disk of oiled leather let into it, so as to correspond with the surface of the apex of the receiver E, which is ground as true as possible. Hence, a slight pressure from the screw G renders the joint made between the apex of the receiver and the spring air-tight; while at the same time the bore of the cock H communicates with the cavity of the receiver by means of a perforation through the leather and spring. On the other hand the relaxation of the screw permitting the spring to rise, opens a communication between the cavity of the receiver and the external air. The cock H, supported by the spring, carries a gallows with a screw I, which serves to fasten a small brass casting, so perforated and fitted as to produce a communication between the cock H, and two others K L, with which the ends of the casting are severally furnished. The cock K serves to open or close the communication with the gauge M, and bell-glass within the jar N. The bell-glass is furnished with a cock, upon which the socket O of the gauge screws.

Description of the Water-Gauge.

The gauge consists of three tubes, the interstices between which are partially supplied with water. In the first place a larger and outer glass tube O M, open at the upper end, is at the lower end cemented into a socket attached to the cock O of the bell-glass. Secondly, a small tube of varnished copper, the axis of which is made to coincide with that of the larger tube, is inserted into the bore of the cock. Lastly, a glass tube, in size and situation intermediate between the tubes just mentioned, and open at the lower end, at the upper end enters the pipe Q, which communicates with the bore of the cock K, and of course, when this is open, with the cavity of the receiver. When water is poured into the tube M, if the pressure within and without be *in equilibrio*, it rises in the interstices between the three tubes to the same height; but whenever there is any diversity of pressure between the air of the inner and outer glass tubes, it is indicated by a consequent difference in the height of the liquid columns included.

Descrip-

Description of the Contrivance for the removal of Carbonic Acid from the Gas left after exploding Gaseous Mixtures; partly consisting of the Compounds of Carbon.

The glass receptacle R fastens by means of a gallows screw to a knob at the end of a perforated cylindrical projection from the cock L, so as, with the aid of interposed leather, to make an air-tight juncture. Between the gallows screw and the receptacle, another cock S is interposed, the bore of which communicates by means of corresponding perforations with that of the cock L.

Below the receptacle a caoutchouc bag is fastened, which, as well as the receptacle, must be filled with lime-water.

Means of causing the Explosion of Gaseous Mixtures within the Receiver of the Sliding-Rod Eudiometer.

A gaseous mixture, when contained in the sliding-rod eudiometer, may be inflamed by galvanic ignition excited in a platina wire, in a mode analogous to that already described in the case of the barometer-gauge eudiometer. See Phil. Mag. and Annals, vol. iv. p. 130.

The circuit is established by means of the leaden rods *x x*, one of which communicates with the mercury of the cistern, while the other is fastened to the insulated wire by means of the gallows *z*. To the rod which communicates with the mercury, a piece of iron should be soldered so that the lead need not be immersed, and consequently corroded. The insulated wire, where it enters the cavity of the eudiometer, is made air-tight by means of a small stuffing-box. It is protected from the mercury within the receiver by a covering of twine, well soaked in and coated with shell lac varnish.

Determination of the Quantity of Carbonic Oxide in a Gaseous Mixture, by the improved Mercurial Sliding-Rod Eudiometer.

In the first place the mixture must be well washed with lime-water, or a caustic alkaline solution, in order to remove carbonic acid, if present. In the next place let us imagine the bell-glass O N, after being adequately supplied over the pneumatic cistern with equal measures of the purified mixture and oxygen gas, has been transferred to the jar I, containing a sufficiency of water to displace the gaseous mixture as required.

In order to fill the receiver with gas, through the gauge-tube and the pipe Q, by which it communicates with the gaseous mixture in the bell-glass, the eudiometer must be filled with mercury to the total exclusion of air, and the sliding-rod wholly within its tube. Under these circumstances the spring being pressed upon

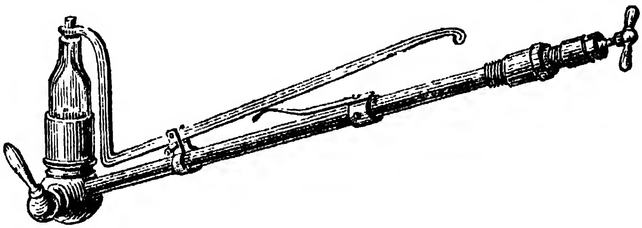
upon the apex of the receiver by the screw G, and the three cocks H K O being open; on drawing out the rod the receiver will be proportionally supplied from the bell-glass with the gaseous mixture. The receiver being thus supplied, the cock O of the bell closed, and K and H being open, on pushing the rod home, the gaseous mixture, driving the air before it through the interstices between the gauge-tubes, will in part effect its escape, in part supply in the tubes the place of the air which it has expelled. This process may be repeated two or three times. After the atmospheric air has in this way been removed from the apparatus, the cocks between the bell and receiver being open, if the rod be drawn out 200 degrees, 200 measures of the mixture, consisting of 100 of each gas, will enter the eudiometer. This being effected, the cock of the bell must be closed. In consequence of the hydrostatic pressure to which the gas will have been subjected in the bell, its density within the receiver will be unduly great. Hence the pressure of the screw on the spring must be relaxed until the gauge indicate that the gas within the receiver has, by the escape of a portion of it, become, with respect to pressure, *in equilibrio* with the atmosphere. The cock communicating with the gauge is then to be closed, the pressure on the spring restored, and an explosion effected. The communication with the gauge is now to be opened. The indicated deficit must be compensated and measured by pushing in the rod, until the columns of water in the interstices of the gauge are on a level. In the next place, close the cock K communicating with the gauge, and open the cocks H L S, which are between the receiver and the receptacle R. Into this receptacle, by forcing the rod home, the gas is to be transferred. Being agitated with the lime-water, it is drawn back into the eudiometer, brought into *equilibrium* with the atmosphere, by appealing again to the gauge, and then measured by noticing the number of graduations which the sliding-rod must enter, in order to effect its expulsion. This residual air, and the deficit produced by the explosion being deducted from 200, the remainder will be the quantity of the carbonic acid, and of course of carbonic oxide originally in the mixture; since carbonic oxide, in passing to the state of carbonic acid, absorbs half of its bulk of oxygen without any enlargement of volume.

Analysis of Olefiant Gas.

As a volume of this gas has been ascertained to be equivalent to two volumes of carbon and two volumes of hydrogen, it must require three volumes of pure oxygen for its complete combustion, and must leave, after the union, two volumes of carbonic

carbonic acid. In order to insure a competent supply of oxygen, four volumes of it may be mixed with one of the olefiant gas in the bell-glass, and the same manipulation resorted to as in the case of carbonic oxide, excepting that before the explosion, the rod V must be drawn out to the greatest extent; and that as soon as the explosion has taken place, the rod must be returned into the tube, so as nearly to compensate the condensation before resorting to the gauge.

Fig. 2.—*Subsidiary Eudiometer.*



Of the Use of the Sudsidiary Eudiometer.

It may sometimes happen that the quantity of gas to be examined may be too small to be measured into the bell-glass by a volumeter, as above described. In that case, a subsidiary eudiometer is employed. Excepting that it is shorter, the rod in this instrument has precisely the same dimensions as in that described in the preceding article; and the graduation in both is exactly the same. The use of the spring and lever, also the method of manipulation, has been described in Phil. Mag. vol. lxvii. page 21.

Analysis of Cyanogen.

Let us suppose it were an object to ascertain the products which result from the combustion of a volume of cyanogen.

A quantity of oxygen gas amply sufficient for the intended experiments must be introduced into the bell-glass N, (fig. 1.) and two hundred measures drawn into the receiver of the principal eudiometer, the manipulation being the same as above described in the case of the mixture. In the next place the subsidiary eudiometer must be supplied with 100 measures of cyanogen, by introducing the apex into a bell-glass containing the gas over mercury, and duly drawing out the rod, the orifice of the receiver being kept open by pressing on the lever, only while above the surface of the mercury, and inside of the bell. The gas thus taken into the subsidiary instrument is next to be transferred to the principal one, *which must in this case be placed over the mercurial reservoir*, and be filled with mercury, the rod V being half withdrawn from its tube. By

By moving the lever D, a communication must also be opened between the receiver E and the reservoir, and the apex of the subsidiary eudiometer must be introduced into a funnel-shaped cavity, with which the cock C is furnished. The rod of the subsidiary instrument being, under these circumstances, pushed home, the gas must pass from it into the funnel-shaped cavity, and thence rise into the receiver above it. When this object has been effected, close the communication with the reservoir, and open that with the iron tube *t t*; also open the cock H. Then appealing to the gauge, adjust the rod so that the pressure of the included gas may be *in equilibrio* with that of the atmosphere. An explosion is now to be effected; after which on opening the gauge, if the cyanogen be pure, there will be no condensation*. The residual gas, by transfer to the receptacle, may be deprived of carbonic acid; and the deficit thus arising may be measured by transferring what remains to the receiver, and ascertaining how many measures the rod must enter, in order to eject it into the air, or to return it into the receptacle.

Modifications of the Eudiometer, described in the preceding Article.

The opposite figure represents another form of the sliding-rod eudiometer, in which the apparatus for the removal of carbonic acid is omitted. The gauge in this eudiometer is attached to the cock of the receiver, instead of surmounting the bell-glass. It answers equally well in either situation.

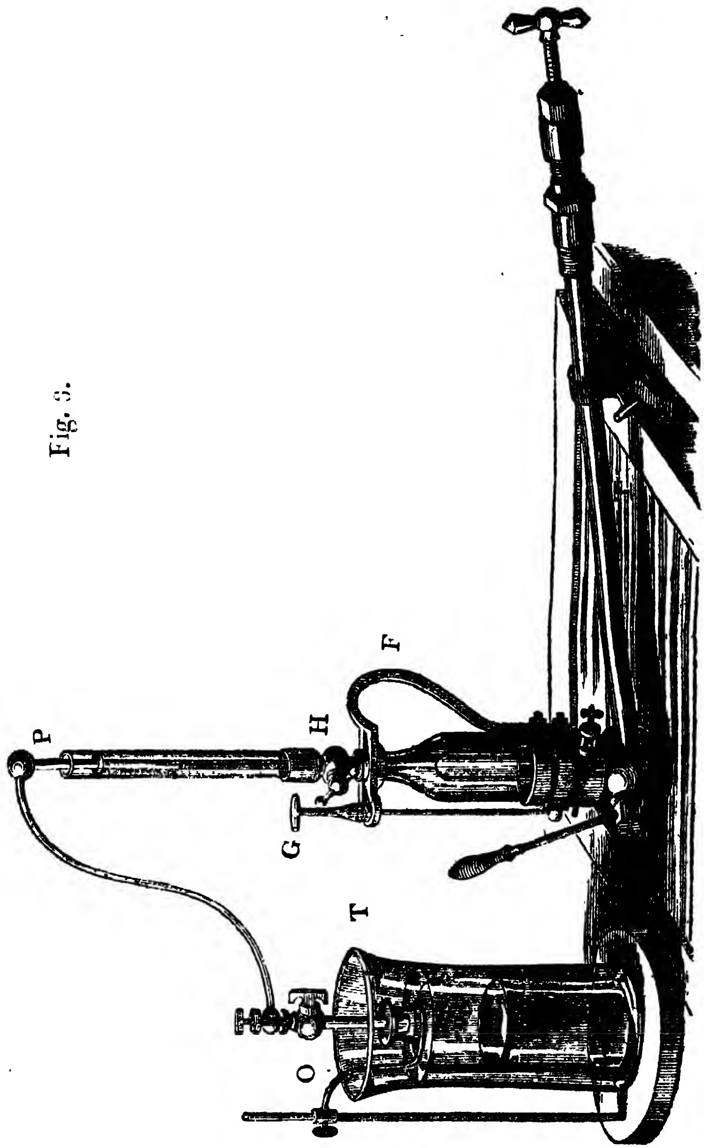
If, instead of the bell and jar, a self-regulating reservoir of hydrogen were attached to the flexible pipe, a convenient arrangement would be obtained for ascertaining the proportion of oxygen in the atmosphere. In that case the mode of operating would be as follows. The pipe and tubes of the gauge being filled with hydrogen, and the receiver with mercury, also the cocks H and O being open, draw out the sliding-rod 50 degrees. A quantity of hydrogen, in bulk equivalent to the part of the rod withdrawn, will pass from the reservoir through the flexible pipe into the cavity of the receiver. The cock O being shut, on appealing to the gauge it will be found that the hydrogen, in consequence of the hydrostatic pressure of the reservoir, will be a little denser than if *in equilibrio* with the atmosphere. By relaxing the pressure of the screw G upon the spring, as much hydrogen will escape as may be necessary to

* Before the explosion, two volumes of oxygen and one of cyanogen are present; the latter comprising two volumes of carbon, and one of nitrogen. During the inflammation, the carbon is transferred to the oxygen without altering it in bulk, while the nitrogen is set at liberty, uncondensed, so as to occupy as much space as the cyanogen did previously.

produce

produce an equilibrium. If while the cavity of the receiver is thus in communication with the atmosphere, the cock H be-

Fig. 3.



ing shut, the sliding-rod be drawn out 100 degrees further, so as to reach to 150 on the scale, 100 measures of air must en-

ter. The pressure of the screw G upon the spring F being restored, and an explosion effected, agreeably to the directions already given, by returning the rod into its tube, more or less, and appealing to the gauge, the deficit may be ascertained. If no error shall have taken place, expelling the residual gas will just return the rod to the situation which it occupied when the experiment commenced. Of the deficit, of course one-third is due to oxygen. It may be proper to mention that some delay is necessary, in order to permit the residual gas to part with the heat acquired from the combustion of the hydrogen and oxygen.

As for the analysis just described, the eudiometer may, as represented in the preceding figure, be seated in a cup of mercury, instead of being placed over a mercurial reservoir; and since the apparatus, when once put into operation, enables us to multiply experiments with great facility, it will be found peculiarly well calculated for a series of observations under circumstances in which access to a pneumatic cistern cannot be had.

Eudiometrical Apparatus analogous to the preceding, excepting that it is constructed of Brass, used with Water, and that Explosions are caused in it by an Electric Spark.

In the analysis of atmospheric air, agreeably to the process last described, no gaseous product being generated which is absorbable by water, it is not necessary to employ mercury, and, consequently, to have the metallic part of the eudiometer of iron and steel. It is in fact preferable to have it of brass, as in that case it will not rust, and may be kept in operation for many months without requiring much adjustment. I have an apparatus thus made, and so contrived as to be ignited by an electric spark. Excepting the substitution of brass for iron, there is no material difference between that apparatus and the one represented by the figure, excepting that the receiver E is exchanged for one of which there is a representation ni *Phil. Mag.* vol. lxvii. p. 22, fig. B.

In the brass eudiometer last described, the cock C is omitted; while, at right angles to the receiver, a small cock is inserted, which supports a glass vessel holding water. By these means, any excess or deficiency of this liquid is easily remedied, and the employment of the cup beneath the eudiometer rendered unnecessary.

[To be continued.]

XX. *On*

XX. *On the Integration of the General Equations of the Motion of Incompressible Fluids.* By J. Challis, *Fellow of Trin. Coll. Cambridge, and of the Cam. Phil. Soc.* *

THE theoretical investigation of the laws of motion of incompressible fluids, conducted in the most general manner possible, leads to the equations,

$$\frac{p}{\rho} = \mathrm{V} - \frac{d\varphi}{dt} - \frac{1}{2}\left(\left(\frac{d\varphi}{dx}\right)^2 + \left(\frac{d\varphi}{dy}\right)^2 + \left(\frac{d\varphi}{dx}\right)^2\right) \qquad (1)$$

$$\frac{d^2\varphi}{dx^2} + \frac{d^2\varphi}{dy^2} + \frac{d^2\varphi}{dz^2} = 0 \qquad (2)$$

$$u = \frac{d\varphi}{dx}, \quad v = \frac{d\varphi}{dy}, \quad w = \frac{d\varphi}{dz}. \qquad (3)$$

(*Poisson, Traitè de Mécanique*, tom. ii. p. 486.)

ρ is the density of the fluid, p the pressure at any point, the co-ordinates of which are x, y, z; u, v, w, are the velocities in the directions of x, y, z, respectively; $d\mathrm{V} = \mathrm{X}dx + \mathrm{Y}dy + \mathrm{Z}dz$, X, Y, Z, being the accelerative forces impressed at the point; and φ is a function of x, y, z, and t, such that

$$(d\varphi) = udx + vdy + wdz.$$

Consequently the above equations apply only to cases in which $udx + vdy + wdz$ is a complete differential of x, y, and z.

Before any use can be made of equations (1) and (3), the function φ must be obtained from (2). This has been effected approximately by the method of series, and the equations have been made available in a few particular instances. It is however certain that an exact integral of (2) may be found by putting $x^2 + y^2 + z^2 = r^2$; and as every integral must have a meaning, I propose to consider what is the meaning of the integral thus obtained.

As $\quad r^2 = x^2 + y^2 + z^2, \; \frac{d\varphi}{dx} = \frac{d\varphi}{dr}\cdot\frac{dr}{dx} = \frac{d\varphi}{dr}\cdot\frac{x}{r}.$

$$\frac{d^2\varphi}{dx^2} = \frac{d^2\varphi}{dr^2}\cdot\frac{x^2}{r^2} + \frac{d\varphi}{dr}\left(\frac{1}{r} - \frac{x^2}{r^3}\right).$$

Hence $\quad \frac{d^2\varphi}{dx^2} + \frac{d^2\varphi}{dy^2} + \frac{d^2\varphi}{dz^2} = \frac{d^2\varphi}{dr^2}\cdot\frac{x^2+y^2+z^2}{r^2} + \frac{d\varphi}{dr}\left(\frac{3}{r} - \frac{x^2+y^2+z^2}{r^3}\right)$

$$= \frac{d^2\varphi}{dr^2} + \frac{2d\varphi}{rdr} = 0.$$

But $\quad \frac{d.r\varphi}{dr} = \varphi + \frac{rd\varphi}{dr}$; and $\frac{d^2.r\varphi}{dr^2} = \frac{2d\varphi}{dr} + \frac{rd^2\varphi}{dr^2}.$

Therefore $\quad \frac{d^2.r\varphi}{rdr^2} = 0.$

* Communicated by the Author.

 Integrating,

Integrating, $\frac{d \cdot r \phi}{d r} = f(t)$, for the differentiations are relative to x, y, z, t being constant. Integrating again,

$$r \phi = f(t) r + \mathrm{F}(t)$$
$$\therefore \phi = f(t) + \frac{\mathrm{F}(t)}{r}$$

The velocity $= \sqrt{\left(\frac{d \phi}{d x}\right)^2 + \left(\frac{d \phi}{d y}\right)^2 + \left(\frac{d \phi}{d z}\right)^2} = \frac{d \phi}{d r}$. Hence if $q =$ the velocity,

$$q = -\frac{\mathrm{F}(t)}{r^2}.$$

The value of ϕ contains two arbitrary functions, as it ought; also it is such that $(d \phi)$ is a complete differential of x, y, and z. Nothing appears in the mode of obtaining the above integral to forbid our saying that it is the proper general integral of the differential equation. The supposition $x^2 + y^2 + z^2 = r^2$, by no means limits its generality. We are rather taught something about the general character of the motion by the possibility of obtaining ϕ in terms of a single variable. Plainly r is the distance of the point under consideration from the origin of coordinates; and the inference to be drawn is, that in general a particle is moving in such a manner that its velocity varies inversely as the square of its distance from some point, and its motion is directed either from or towards this point. I say *some point*, because the origin of coordinates is perfectly arbitrary. The generality of the inference is legitimately deduced both from this circumstance, and because as no supposition was made about the manner of putting the fluid in motion in the investigation of the differential equations, so none has been made in the foregoing reasoning founded on them. All this will be clearly understood by conceiving a sphere of the fluid to be inclosed in an envelope capable of expansion, and a small spherical ball of solid matter to be introduced into it, and placed concentric with it. Let $r =$ the radius of the ball, $\mathrm{R} =$ that of the sphere before the introduction of the ball, and δ its increment afterwards.

Then $\qquad \pi \mathrm{R}^2 \delta = \frac{4 \pi r^3}{3}$, r being very small,

$$\delta = \frac{4 r^3}{3 \mathrm{R}^2}$$

δ will also represent the translation from its original position of a particle at any distance R from the centre. Consequently if the particles be conceived to change their positions by a uniform motion of translation in the directions of the radii of the sphere

sphere, the velocity of each will vary inversely as the square of the distance from the centre. It is this law of their motions that the equation $q = -\frac{F(t)}{r^2}$ points out. If a disturbance act at the origin of coordinates, the motions consequent upon it will be the same at the same distance from the origin in all directions at a given instant, provided $F(t)$ be the same for all directions; that is, if the disturbance be similarly related to all the parts of the surrounding space, as in the instance just adduced. But, generally speaking, the form of the function $F(t)$ will be different for every different direction from the point of disturbance, and will vary from one direction to another, either according to a law, or in a manner regulated by no law of continuity. All this flows from the arbitrary nature of the functions introduced by the integration of a partial differential equation. We may however conclude, that if a pyramid, the vertical angle of which is very small, be placed with its vertex at the point towards which, or from which, the motion tends; for all or a given portion of the particles included within its faces, $F(t)$ will be ultimately the same at a given instant, and consequently the velocities at that instant will at different distances from the vertex vary inversely as the square of the distances. An instance of motion in obedience to the law here considered, is afforded by fluid issuing from a small orifice. The portion of fluid included between the orifice and the *vena contracta*, constitutes a frustum of a cone, and at a given instant the velocities of the particles vary inversely as the square of their distances from its vertex.

If we now choose an origin of coordinates and axes, the positions of which are fixed in space, if x, y, z, be the coordinates of a point at which the velocity is q, and α, β, γ, be those of the point towards which, or from which the motion tends,

$$q = \frac{-F(t)}{(x-\alpha)^2 + (y-\beta)^2 + (z-\gamma)^2}$$

and

$$\phi = f(t) + \frac{F(t)}{\sqrt{(x-\alpha)^2 + (y-\beta)^2 + (z-\gamma)^2}},$$

for the equation $\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} + \frac{d^2\phi}{dz^2} = 0$ is satisfied by this value of ϕ. α, β, γ, vary in general with the time, and depend, as well as the form of F, on the given conditions of the problem to be solved. Also the differential equation is satisfied by

$$\phi = f(t) + \frac{F_1(t)}{\sqrt{(x-\alpha')^2 + (y-\beta')^2 + (z-\gamma')^2}} + \frac{F_2(t)}{\sqrt{(x-\alpha'')^2 + (y-\beta'')^2 + (z-\gamma'')^2}}$$

+ &c. to as many terms as we please. This equation is applicable

cable to the motion of a particle which is affected simultaneously by several independent causes, and it may be inferred that the motion is the resultant of the several motions due to the causes when they act separately. The equation applies, therefore, to any motion whatever.

Suppose now the fluid to be of two dimensions. The equation for determining ϕ in this case is $\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} = 0$.

Let $x^2 + y^2 = r^2$. $\frac{d\phi}{dx} = \frac{d\phi}{dr}$, $\frac{d^2\phi}{dx^2} = \frac{d^2\phi}{dr^2} \cdot \frac{x^2}{r^2} + \frac{d\phi}{dr}\left(\frac{1}{r} - \frac{x^2}{r^3}\right)$. Hence $\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} = \frac{d^2\phi}{dr^2} + \frac{d\phi}{r\,dr} = 0$.

But
$$\frac{d \cdot \frac{r\,d\phi}{dr}}{dr} = \frac{d\phi}{dr} + \frac{r\,d^2\phi}{dr^2}$$

Hence
$$\frac{d \cdot \frac{r\,d\phi}{dr}}{r\,dr} = 0$$
$$\frac{r\,d\phi}{dr} = f(t); \quad \frac{d\phi}{dr} = \frac{f(t)}{r};$$
$$\phi = f(t) \log. r + \mathrm{F}(t).$$

The meaning of the result, vel. $= \frac{f(t)}{r}$, may be illustrated, as before, by conceiving the fluid to be contained in a cylinder capable of expansion in the direction of the radii, and a small cylinder of solid matter to be placed with its axis coincident with that of the other. Let $r =$ the radius of the solid cylinder, R of the fluid cylinder before the introduction of the solid, δ its extension afterwards, $h =$ the common height of the cylinders.

Then $\pi r^2 h = 2\pi \mathrm{R} h \delta$, r being very small;
$$\delta = \frac{r^2}{2\mathrm{R}}$$

And if the translation of each of the particles be supposed to be effected by a uniform motion, δ will represent the velocity at any distance R from the axis.

As the general integral of $\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} = 0$ is also
$$\phi = \mathrm{F}(x + y\sqrt{-1}) + f(x - y\sqrt{-1})$$
it is important to show that this is equivalent to the integral above obtained.
$$\frac{d\phi}{dx} = \mathrm{F}'(x + y\sqrt{-1}) + f'(x - y\sqrt{-1})$$
$$= \mathrm{A} + \mathrm{B}\sqrt{-1} + \mathrm{A}' - \mathrm{B}'\sqrt{-1};$$

for

for it has been long ago proved that every impossible quantity may be put under the form $a \pm b \sqrt{-1}$.

$$\frac{d\varphi}{dy} = \sqrt{-1}\, F'(x + y\sqrt{-1}) - \sqrt{-1}\, f'(x - y\sqrt{-1})$$
$$= A\sqrt{-1} - B - A'\sqrt{-1} - B'.$$

Hence $\frac{d\varphi}{dx}$ and $\frac{d\varphi}{dy}$ cannot both be possible unless $B = B'$, and $A = A'$, that is, unless F' and f' be the same functions. As the direction of the axes is quite arbitrary, suppose $y = 0$. Then $\frac{d\varphi}{dx} = 2\, F'(x)$, and $\frac{d\varphi}{dy} = 0$. This proves that the velocity is directed to or from the origin of coordinates, and is equal to twice a function of the distance of the same form as F'. Hence,

$$\frac{d\varphi}{dy} = \sqrt{-1}\Big(F'(x + y\sqrt{-1}) - F'(x - y\sqrt{-1})\Big) = \frac{2y}{r} F'(r).$$

Let $x + y\sqrt{-1} = m$, $x - y\sqrt{-1} = n$; so that

$$2y = (n - m)\sqrt{-1}, \qquad r^2 = mn.$$

$$\therefore\ F'(m) - F'(n) = \frac{n - m}{\sqrt{mn}} . F'(\sqrt{mn})$$
$$= \sqrt{\frac{n}{m}} . F'(\sqrt{mn}) - \sqrt{\frac{m}{n}}\, F'(\sqrt{mn}).$$

As this equation is identical, $F'(m)$ is the same as $\sqrt{\frac{n}{m}} \times F'(\sqrt{mn})$: hence $F'(\sqrt{mn})$ must $= \frac{C}{\sqrt{mn}}$. This form of the function evidently satisfies the equation. Hence $q = 2\, F'(r) = \frac{2\, C}{r} = \frac{1}{r} \times$ an arbitrary function of t, the same result as before.

When the motion is in space of one dimension,

$$\frac{d^2\varphi}{dx^2} = 0, \qquad \frac{d\varphi}{dx} = f(t) = q; \quad \varphi = f(t)\,x + F(t).$$

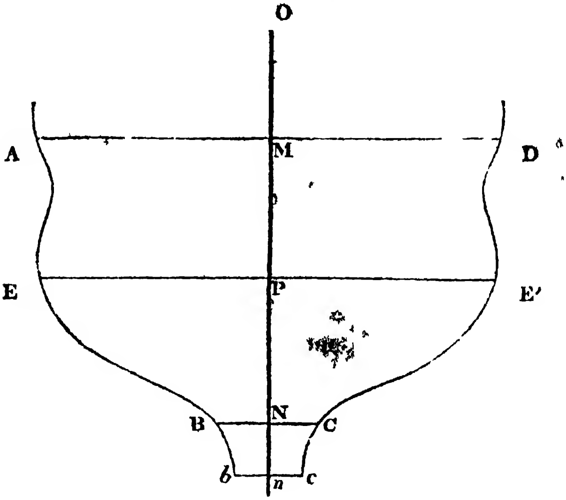
Hence $\quad \frac{d\varphi}{dt} = f'(t)\,x + F'(t) = \frac{x\,dq}{dt} + F'(t).$

Substituting in the general equation (1),

$$\frac{p}{\rho} = V - \frac{x\,dq}{dt} - \frac{q^2}{2} - F'(t).$$

I proceed to apply this equation to a problem of considerable interest. Suppose a vessel A B C D, formed by the revolution of a line A E B, which may be either continuous or broken, about an axis O N, to contain fluid always retained at

at a constant level AMD, and let the fluid issue from a circular orifice BC, through the centre of which the axis passes.



There must be a very slender column of fluid, having its axis coincident with MN, the particles in which move entirely in a vertical direction, because there can be no reason why they should move in one horizontal direction rather than another. To this column, even if it be supposed to be continued out of the vessel, the preceding equation will apply with exactness, because q being $= f(t)$, we need not have regard to the law of continuity in the values of q. This being premised, let $k =$ the area of the orifice BC, $OP = x$, $u =$ the velocity at N, $q =$ that at P, and z an arbitrary function of x, such that $q = \frac{ku}{z}$.

Then $$\frac{dq}{dt} = \frac{k}{z} \cdot \frac{du}{dt} - \frac{ku}{z^2} \cdot \frac{dz}{dt}$$

$$\frac{du}{dt} \quad \frac{ku}{z^2} \cdot \frac{dz}{dx} \cdot \frac{dx}{dt}$$

And $$\frac{dx}{dt} = q, \text{ also } dV = g\,dx, \quad V = gx$$

$$\frac{p}{\rho} = gx - \frac{kx}{z} \cdot \frac{du}{dt} - \frac{k^2u^2}{z^2}\left(\frac{1}{2} - \frac{x\,dz}{z\,dx}\right) + F'(t).$$

Let $z' =$ the area of the upper surface of the fluid. Then at M the velocity $= \frac{ku}{z'}$, because the vertical velocity at the surface must be less than that at the orifice in the ratio of

k to

k to z'. Also if P = the atmospheric pressure, and $OM = x'$,

$$\frac{P}{\rho} = g\,x' - \frac{k\,x'}{z'}\cdot\frac{du}{dt} - \frac{k^2 u^2}{z'^2}\left(\frac{1}{2} - \frac{x'\,dz'}{z'\,dx'}\right) + F'(t)$$

$$\therefore\ \frac{p-P}{\rho} = g(x-x') - k\left(\frac{x}{z} - \frac{x'}{z'}\right)\frac{du}{dt} - \frac{k^2 u^2}{2}\left(\frac{1}{z^2} - \frac{1}{z'^2} - \frac{2\,x\,dz}{z^3\,dx} + \frac{2\,x'\,dz'}{z'^3\,dx'}\right)$$

At the orifice $p = P$ without sensible error, and $z = k$. Let $x = h$, and for simplicity sake suppose $x' = 0$, or the origin to be at M. Then,

$$0 = g\,h - h\frac{du}{dt} - \frac{u^2}{2}\left(1 - \frac{k^2}{z'^2} - \frac{2\,h}{k}\cdot\left(\frac{dz}{dx}\right)\right)$$

$\left(\frac{dz}{dx}\right)$ represents the value of $\frac{dz}{dx}$ when h is substituted for x. As the velocity of issuing must after a very short time become uniform, $\frac{du}{dt}$ will very soon after the commencement of the motion be = 0. Also $\frac{k}{z'}$ is very small when the orifice is small.

$$\therefore\ u^2 = \frac{2\,g\,h}{1 - \frac{2\,h}{k}\left(\frac{dz}{dx}\right)}.$$

This equation is sufficient to show that at the orifice the velocity is always less than that acquired by falling through h, for $-\left(\frac{dz}{dx}\right)$, which, when the orifice is very small, expresses the rate of decrement of the section of the stream in passing through it, is always a positive quantity.

The experiments of Venturi show that the value of $-\left(\frac{dz}{dx}\right)$ is less as h is greater, for he found that by increasing the height of the surface of the fluid above the orifice, the distance of the vena contracta from the orifice was also increased.

Suppose now k to be the area of the section of the stream at the vena contracta $b\,n\,c$, the depth of which $M\,n$ below the surface is h. For a small distance on each side of the vena contracta the function z will be accurately equal to the section of the stream, and consequently will be a minimum at the vena contracta by the definition of it. Hence $\left(\frac{dz}{dx}\right) = 0$

and $$u^2 = 2\,g\,h,$$

exactly in conformity with experience.

The above is, I believe, the most exact solution of the problem that has hitherto been given, as the velocity at the vena contracta has never before been a deduction from theory. It may not be amiss to show that our reasoning will lead to the solution in M. Poisson's Treatise on Hydrostatics, if conducted upon the supposition that he makes. In general

$$\frac{p-p'}{\rho}=g(x-x')-k\left(\frac{x}{z}-\frac{x'}{z'}\right)\frac{du}{dt}-\frac{k^2u^2}{2}\left(\frac{1}{z}-\frac{1}{z'^2}-\frac{2\,x\,dz}{z^3\,dx}+\frac{2\,x'\,dz'}{z'^3\,dx'}\right).$$

M. Poisson supposes the vessel to be such that the variation of z is small compared to the corresponding variation of x. Hence if p and p' differ by a very small quantity,

$$\frac{p-p'}{\rho}=g\,(x-x')-k\,\frac{x-x'}{z}\cdot\frac{du}{dt}-\frac{k^2u^2}{2}\left(\frac{1}{z^2}-\frac{1}{z'^2}\right)\text{ very nearly,}$$

and passing from differences to differentials,

$$\frac{dp}{\rho}=g\,d\,x-k\,\frac{dx}{z}\cdot\frac{du}{dt}-\frac{k^2u^2}{2}\cdot d\cdot\frac{1}{z^2},$$

which is the equation in the *Traité de Méc.* tom. ii. p. 449.

Upon the same principles as those by which the preceding problem was solved, it will be possible to find the velocity of the fluid issuing from a vessel of any shape, whatever be the nature and position of the orifice. For let fluid be compelled to move through any canal, continuous or not, and lying in one or several planes, and at the same time let it be acted upon by gravity. Suppose the transverse section at every point to be a square. Then every small portion of it may be considered a frustum of a pyramid; and if the pyramid, the frustum of which is terminated at a given point be completed, and r be the distance of its vertex from this point, by what has been proved,

$$\phi=f(t)+\frac{F(t)}{r},\quad \frac{d\phi}{dr}=-\frac{F(t)}{r^2}=\text{vel.}$$

Now let the transverse sections of the tube be indefinitely diminished, their proportions remaining the same. In this case the motions of the particles perpendicularly to the axis of the canal, will be indefinitely small, and no error will be induced by making r infinite in the preceding expressions, that is in supposing each very small portion of the tube prismatic. Hence since $F(t)$ is arbitrary, we may put $\frac{d\phi}{dr}=\chi(t)$. Again, if s be the distance measured along the axis, of the point under consideration, from a fixed point in the axis, $\frac{d\phi}{ds}=\frac{d\phi}{dr}$, because the line s touches all the lines r.

$$\therefore\ \frac{d\phi}{ds}=\chi(t)$$

$$\phi=f(t)+\chi(t)\,s,$$

equations exactly like those for motion in space of one dimension.

$$\frac{d\phi}{dt}=f'(t)+\chi'(t)\,s$$

and
$$\frac{p}{\rho}=g\,x-\chi'(t)\,s-\frac{\chi^2}{2}-f'(t),$$

x being

x being the distance of the point from a fixed horizontal plane. Suppose $q = \frac{k u}{z}$, z being an arbitrary function of s, not necessarily continuous, to which the transverse section of the tube is always proportional, and u the value of q when $z = k$.

$$\therefore \quad \chi'(t) = \frac{d q}{d t} = \frac{k}{z} \cdot \frac{d u}{d t} - \frac{k u}{z^2} \cdot \frac{d z}{d s} \cdot \frac{d s}{d t}$$

$$= -\frac{k}{z} \cdot \frac{d u}{d t} - \frac{k^2 u^2}{z^2} \cdot \frac{d z}{z d s}$$

$$\therefore \quad \frac{p}{\varrho} = g x - \frac{s k}{z} \cdot \frac{d u}{d t} - \frac{k^2 u^2}{z^2} \cdot \left(\tfrac{1}{2} - \frac{s d z}{z d s}\right) - f'(t).$$

Now as the shape of the tube and the function z are quite arbitrary, the motion which is taking place at any instant along its axis, may be identical with the motion along a line drawn from a point in the surface of fluid, maintained at a constant height in any vessel whatever, to a point at the vena contracta, the line being so drawn that it shall always be coincident with the directions of the motions of the particles through which it passes. Let therefore $u =$ the velocity at the vena contracta, $k =$ the section of the stream at that point, $z' =$ the area of the upper surface of the fluid; then will $\frac{k u}{z'} =$ the vertical velocity of a particle at any point of the surface, if the surface retain its parallelism to the horizon. And if $\theta =$ the $\angle$ which the direction of the velocity of the particle makes with its surface, $\frac{k u}{z' \sin \theta} =$ its actual velocity. Suppose that when $p = P$ the atmospheric pressure, $x = 0$, $s = 0$, $z = z'$.

$$\text{Then } \frac{P}{\varrho} = -\frac{k^2 u^2}{2 z'^2 \sin^2 \theta} - f'(t)$$

$$\therefore \frac{p - P}{\varrho} = g x - \frac{s k}{z} \cdot \frac{d u}{d t} - \frac{k^2 u^2}{z^2} \left(\tfrac{1}{2} - \frac{s d z}{z d s}\right) + \frac{k^2 u^2}{2 z'^2 \sin^2 \theta}$$

At the vena contracta $z = k$, $p = P$, $\frac{d z}{d s} = 0$, because k is a minimum. Let $s = \sigma$.

Hence $0 = g h - \sigma \frac{d u}{d t} - \frac{u^2}{2} \left(1 - \frac{k^2}{z'^2 \sin^2 \theta}\right)$. For almost all the points of the surface θ will be very nearly $90°$; so that if k be very small compared with z', $\frac{k^2}{z'^2 \sin^2 \theta}$ may be neglected. And because the velocity of issuing must very soon be uniform, after a very short time from the commencement of motion $\frac{d u}{d t} = 0$.

Therefore $u^2 = 2 g h$.

It thus appears that independently of the motions of the particles in the interior of the vessel, (for they may be any

whatever as α is an arbitrary function) the velocity at the vena contracta is that acquired by falling through its depth below the surface of the fluid, whatever be the shape of the vessel, or the nature and position of the orifice. The exact conformity of this result to experience is a proof of the justness of the reasoning from which it is deduced.

In general $\phi = f(t) + \frac{\mathrm{F}(t)}{r}$; $\frac{d\phi}{dr} = -\frac{\mathrm{F}(t)}{r^2} = q$; $\frac{d\phi}{dt} = f'(t) + \frac{\mathrm{F}'(t)}{r}$; $\frac{dq}{dt} = -\frac{\mathrm{F}'(t)}{r^2} + \frac{2\,\mathrm{F}(t)}{r^3} \cdot \frac{dr}{dt} = -\frac{\mathrm{F}'(t)}{r^2} - \frac{2q^2}{r}$, for $\frac{dr}{dt} = q$. Hence $\frac{\mathrm{F}'(t)}{r} = -\frac{r\,dq}{dt} - 2q^2$, and $\frac{d\phi}{dt} = f'(t) - \frac{r\,dq}{dt} - 2q^2$. Therefore $\frac{p}{\rho} = \mathrm{V} + \frac{r\,dq}{dt} + \frac{3q^2}{2} - f'(t)$, an equation which embraces every kind of motion, and in which r is a function of x, y, z, and t, always given by the given conditions of the problem to be solved.

It would be easy to multiply examples: the preceding suffice to show that the integral we set out with is the proper general integral of the differential equations of the motion of incompressible fluids, and to give an idea of the mode of employing it. This method of deducing the laws of physical action from the integrals of partial differential equations, is new, I believe, and at the same time, important, as it extends to the more interesting problem of the small vibrations of elastic mediums. By parity of reasoning Euler's integral of the equation $\frac{d^2\phi}{dt^2} = a^2\left(\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} + \frac{d^2\phi}{dz^2}\right)$ is the general integral. This point I have considered in a paper lately submitted to the Cambridge Philosophical Society, and have employed this integral in the solution of some problems hitherto not subjected to analysis. The foregoing discussion also throws considerable light upon the nature of the arbitrary functions which occur in the integrals of partial differential equations. It may be inferred from it, that while we justly admit the discontinuity of these functions, that is, their changing abruptly from one form to another, it is neither necessary nor proper to suppose the existence of a new species of functions, discontinuous *per se*, and by this property of discontinuity distinguished from every other. When Lagrange had shown that the vibratory motions of the particles of elastic mediums were not subject to any law of continuity, it was perhaps too hastily concluded that they must be given by a new order of functions; for it is not logical to draw inferences about physical laws from functions, the existence of which cannot be proved by pure analytical reasoning. This question,

tion, as far as relates to motion in elastic mediums, I have considered in the paper above referred to.

Trin. Coll., April 13th. J. CHALLIS.

XXI. *Notices respecting New Books.*

M. ADOLPHE BRONGNIART'S *History of Fossil Vegetables.*

THE second livraison of this most interesting and beautiful work has recently appeared, and contains figures and descriptions of upwards of thirty species of fossil plants, of the genera *Fucoides, Confervites, Muscites, Equisetum, Calamites,* &c. We regret to learn that from the death of the publisher, the completion of the work will experience some delay; but the learned and indefatigable author has just published a "*Prodrome de l'histoire des végétaux fossiles,*" which is intended as a compendium of the whole work; but it is without plates, or descriptions of species. This little publication is highly interesting; for it contains the author's views of the development of vegetation, and the characters thereby furnished to distinguish the different formations. From the increased and increasing taste for geology, we hope both the works now mentioned will meet with due encouragement from the literati of this country. We subjoin M. Brongniart's list of the plants which characterize the secondary and tertiary formations, extracted from the "*Prodrome*" alluded to.

PLANTES CARACTERISTIQUES DES DIVERSES FORMATIONS.

TERRAIN HOUILLER. *Coal Measures.*

Calamites.

Filices des genres Sphenopteris, Neuropteris, Pecopteris, et *Odontopteris especes tres nombreuses.

Lycopodites et *Lepidodendron. *Sphenophyllum, *Annularia, et *Asterophyllites. Les quatres derniers genres ne se trouvent que dans ces terrains.

ZECHSTEIN et SCHISTES BITUMINEUX.

Algæ analogues à des Caulerpa, particulièrement *Fucoides selaginoides.

GRE'S BIZARRE.

Calamites.

Filices des genres Sphenopteris, Neuropteris, et *Anomopteris.

Conifères du genre *Voltzia.

Plusieurs plantes phanerogames monocotyledones.

MUSCHELKALK.

Neuropteris Gaillardati.

Mantellia cylindrica.

MARNES IRISEES. *Keuper et Lias.*

*Equisetum columnare.

Filices des genres *Clathropteris, Teniopteris. Cycadeæ des genres *Pterophyllum, *Nilsonia et Zamites; particulièrement le *Pterophyllum longifolium et les Zamites Bechii et Bucklandii.

OOLITHE INFERIEURE. *Oolite of Whitby.*

Equisetum columnare.

Filices des genres *Pachypteris, Sphenopteris, Pecopteris, et Teniopteris.

Cycadées du genre *Zamia (9 especes).

FOREST MARBLE. (*Stonesfield and Solenhofen.*)

Fucoides.

Filices rares. Sphenopteris, Hymenophilloides.

Zamia pectinata.

Coniferæ du genre Thuytes et *Taxites podocarpoides.

CALCAIRE DE PORTLAND.

Mantellia nidiformis. (*Cycadeæ.*)

HASTINGS SAND.

*Lonchopteris Mantelli. (*Pecopteris reticulata.*)

*Sphenopteris Mantelli.

*Clathraria Lyellii.

GREEN SAND.

Fucoides, plusieurs espèces. *F. Targionii, strictus, et Brardii.

Zosterites. Cycadites Nilsonii.

CRAIE.

Rien de determinables en plantes terrestres.

Confervites, fucoides, rares.

ARGILE PLASTIQUE, MOLASSE ET LIGNITES.

Palmiers probablement du genre Cocos, &c.

Coniferæ des genres Pinus, Thuya, Taxus, &c.

Amentaceæ, Acerineæ, Juglandeæ, et autres dicotyledones arborescentes.

CALCAIRE GROSSIER.

Palmiers. *Rares.*

Coniferæ. *Rares.*

Pinus Defrancii, feuilles dicotyledones assez frequentes.

Fucoides nombreuses à Monte Bolca.

TERRAIN D'EAU DOUCE, GYPSEUX OU PALEOTHERIEN.

Chara Lemani.

Palmiers. Flabellaria Lamanonis.

Coniferæ. Pinus pseudo-strobus. Taxites Tournalii, &c.

Amentaceæ, Carpinus; Betula et autres dicotyledones.

TERRAIN MARIN SUPERIEUR.

Pinus Cortesii; végétaux rares et peu connus.

TERRAIN D'EAU DOUCE SUPERIEUR. (*Meulières.*)

*Chara medicaginula.

*Nymphea.

* Cettes plantes qui ne sont propres qu à une seule formation ou à deux formations très voisines, sont marquées d'un *.

XXII. *Pro-*

XXII. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

May 29.—A PAPER was read On the nerves of the face; being a second paper on that subject, by Charles Bell, Esq. After recapitulating the contents of his former paper, the author cited cases which have occurred since its publication in support of his doctrine; 1st, That the sensibility of the head and face depends on the fifth pair of nerves; 2ndly, That the muscular branches of that pair are subservient to mastication; and 3rdly, That the *portio dura* of the seventh pair controls those motions of the parts of the face, whether voluntary or involuntary, which are connected with respiration. Instances are given of lesions of the portio dura, from accident or from disease, followed by paralysis of the muscles on the same side of the face, while the sensibility remained. On the other hand, cases are related of injury to the fifth pair being attended with loss of sensibility in all the parts receiving branches from the injured nerve, while the power of motion continued unimpaired. In one case of this description, where one half of the under lip had become insensible, on a tumbler being applied to the mouth, the patient imagined it was a broken glass that he touched. A similar delusion was experienced by another patient, in whom the half of the upper lip had been deprived of sensation by an injury to the suborbital branch on the same side. From these facts the author deduces the absurdity of the practice of cutting the portio dura for the relief of tic-douloureux. He next enters into an anatomical description of the course of that division of the fifth pair of nerves which is unconnected with the Gasserian ganglion, and passes under it, and which he considers the motor or manducatory portion of the fifth, being distributed to the temporal, masseter, pterygoid, and buccinator muscles: some branches of it supplying the muscles of the lips, and also the mylo-hyoideus and anterior belly of the digastricus, the action of which is to repress the jaw. In proof that this nerve is destined to manducation, the root of the fifth pair in an ass being exposed and irritated, the jaws closed with a snap; and, on its being divided, the jaw fell relaxed and powerless. The author next endeavours to show the necessity of an accordance between the motions of the lower jaw and those of the cheeks during mastication, and the probability that this connection of motions is brought about by means of the connections which exist among their respective nerves, and between which a sympathy may in consequence be established. In one case violent spasms took place in the masseter and temporal muscles, while the motions of the features were free and unconstrained; and in another the muscles of the jaw on one side were paralysed, with loss of sensibility on that side of the face. On the other hand, when the portio dura is paralysed, all the muscles of the face waste, except those supplied by the fifth pair.

LINNÆAN SOCIETY.

May 5.—The paper read was "Some account of the Geology and Botany of Swan River, Australia. By Mr. Charles Fraser, colonial botanist."

May 25.—The Anniversary was held at the Society's House, A B. Lambert, V.P. in the chair; when the following were appointed officers.

President: Edward Lord Stanley, M.P.—*Vice-Presidents:* A. B. Lambert, Esq. F.R.S.; W. G. Maton, M.D. F.R.S.; E. Forster, Esq. F.R.S.; and R. Brown, Esq. F.R S. &c.—*Treasurer:* Edward Forster, Esq. F.R.S.—*Secretary:* J. E. Bicheno, Esq. F.R.S. *Assistant Secretary:* Richard Taylor, Esq. F.S.A. &c.—Also to fill the vacancies in the Council: Thomas, Marquis of Bath, F.S.A.; W. J. Broderip, Esq. F.R.S.; R. E. Grant, M.D. F.R.S. Ed.; John Lindley, Esq. F.R.S. &c.; and Nathaniel Wallich, M.D. F.R.S. &c. The annual dinner was enlivened by the presence of several much esteemed naturalists from various parts of the kingdom.

June 2.—Read a communication by Wm. Yarrell, Esq. F.L.S. &c. "On the Organs of Voice in Birds." The author here pursues the subject of his former paper on the Tracheæ of birds, and gives descriptions accompanied by figures of the numerous muscles by whose action the varied powers of the vocal organs of birds are governed. Their organs of voice consist of four parts: the *glottis* or superior larynx, the *tube* of the trachea, the *inferior larynx*, and the *bronchiæ*. Great difference exists in the relative length of tube, short ones producing shrill notes, as in singing birds, and *vice versâ* in waders and swimmers. Strong broad cartilaginous rings give loud and monotonous voices, and slender rings with large space between admit variety of tone. Some of these varieties result from the dilatation and contraction of the membrana tympaniformis, and from the power of altering the form of the bronchiæ. The muscles of the inferior larynx vary frompair to five.

June 16.—In the remainder of Mr. Yarrell's paper, the reading of which was concluded at this meeting, a great many curious conformations of the organs of voice in various birds were accurately described and compared. The author states that these are least complex in the Falconidæ, some of the Insessores, almost all the Rasores, Grallatores, and Natatores;—more complex in the Psittacidæ, who alone possess three pair of true muscles of voice; but most complex in the *Corvi*, starling, larks, thrushes, finches, warblers, swallows, &c., which all have five. The convolutions in the trachea of some species are aptly compared to the additional crooks fixed to the French-horn in order to play in a lower key.—A part of a memoir by M. Dumortier was also read, intitled "*Récherches sur la Structure comparée et le Devclloppement des Animaux et des Végetaux.*"

GEOLOGICAL SOCIETY.

June 19.—A. B. De Capel Brooke, Esq, of Lower Brooke Street; James Morrison, Esq., of Portland Place; and Daniel Sharpe, Esq., of New Ormond Street,—were elected Fellows of this Society.

A paper, "On the occurrence of agates in the dolomitic strata of the new red-sandstone formation in the Mendip Hills," by the Rev. W. Buckland, D.D, V.P.G.S, F.R S., &c., &c., was read. These agates are ploughed out of the surface of the fields at Sandford, near Banwell, and are nearly allied to the potatoe-stones, which abound in the

the new-red-sandstone formation which surrounds the Mendip Hills. Their prevailing colours are various shades of gray; their internal structure resembles that of the bird's-eye agate, presenting alternate bands of chalcedony, jasper, and hornstone, disposed in irregular and concentric curves: some specimens from Worle and Clevedon are of the nature of fine jasper-agates, and of a bright red colour.

A shallow pit, from which the agates are extracted at Sandford, presents the following section.

1. Yellow clay, mixed with magnesia and carbonate of lime....................................	6 inches.
2. Yellow dolomite, used as firestone in limekilns; it crumbles readily to a soft powder, and is filled with specks of manganese, and contains veins of small nodules of chalcedony.......................	6 inches.
3. Yellow clay falling to powder in water like Fuller's earth, and containing much carbonate of lime and magnesia. In this clay the agates are dispersed irregularly like nodules of flint in chalk	6 inches.
4. Yellow clay and earthy dolomite, to the bottom of the pit	12 inches.

The author adduces a parallel example of beds and nodules of jasper and jasper-agate in the mountains of dolomite, near Palermo, in a formation of the same age with the new-red-sandstone of the Mendip Hills. He also gives examples of agates formed in cavities of chert of the green-sand formation, near Lyme Regis, and in cavities of silicified wood and silicified corals and shells. The most beautiful specimens of the two former are from the tertiary strata of Antigua. Shells converted into chalcedony, and containing agates in their cavities, occur near Exeter, in the whet stone-pits of the green-sand formation, at Black Down Hill; and shells, entirely converted to red jasper, in sand of the same formation, occur at Little Haldon Hill.

A paper was next read "On the tertiary fresh-water formations of Aix in Provence, including the coal-field of Fuveau," by Roderick Impey Murchison, Esq., Sec. G.S., F.R.S., &c., and Charles Lyell, Esq., For. Sec. G.S., F.R.S., &c.; with a description of fossil insects contained therein, by John Curtis, Esq., F.L.S.

The oldest and fundamental rock of this district is a highly inclined and contorted secondary limestone, containing Belemnites, Gryphites and Terebratulæ; on which is unconformably deposited a vast fresh-water formation, the relations of which are shown in a section from N.E. to S.W.—The escarpment of white marl and limestone, N.E. of the town of Aix, is first described in a descending series. The upper beds, consisting of white calcareous marls and marlstone, calcareo-siliceous millstone and resinous flint, contain the Potamides Lamarckii, Bulinus terebra and B. pygmæus, with a new species of Cyclas named C. gibbosa; and the subjacent strata run out into a terrace, beneath which gypsum is extensively worked. Of these beds (minutely detailed), some are peculiarly characterized by their abundance of fossil fish; and others by a profusion of plants, amongst which, Mr. Lindley has recognised Flabellaria Lama-

Lamanonis of M. Ad. Brongniart, and the leaves of Laurus dulcis? Podocarpus macrophylla? and Buxus Balearica?—the terminal pinna of a leguminous plant, referrible to Loteæ or Phaseoleæ of De Candolle, the branch of a Thuya nearly related to T. articulata, and what appears to be the fruit of some unknown plant, &c., &c. In this upper system of gypsum the fossil insects occur, exclusively, in a finely laminated bed of about 2 inches thick; and still lower are two other ranges of gypsum, the upper one of which alone is worked; and the marls associated therewith, contain nearly as great a quantity of fossil fish as those of the upper zone. Beneath these are beds of white and pink-coloured marlstone and marl, inclined at angles of from 25° to 30°, and distinguished by Potamides Lamarckii, and a new species of Cyclas, named C. Aquæ Sextiæ, and these pass downwards into a red-sandstone (Molasse) and a coarse conglomerate (Nagelfluh), the town of Aix being situated at the base of the whole of the above series.

In continuing the sectional line to the S.W., all the district between Aix and Fuveau is made up of parallel ridges of fresh-water rocks; the most northerly containing red marl and fibrous gypsum, with Limnææ and Planorbes (P. rotundatus): the intermediate range is of mere earthy limestone, containing Limnææ and Gyrogonites, with micaceous sandstone and shale; and lastly, the coal-field of Fuveau is described, as composed of gray, blue, and black compact limestone and shale, with stony bituminous coal of good quality; the united thickness of the different seams of which amounts to about 5 feet. The fossils characterizing the carboniferous strata are 2 new species of Cyclas, named C. cuneata and C. concinna, a Melania, named M. scalaris; Planorbis cornu, and a large species of Unio. Casts of Gyrogonites were observed even in the coal itself, and the charcoal seemed in some instances to be made up of a plant resembling Endogenites bacillare of Brongniart.

The authors remark that these lower members of this great tertiary deposit differ in character from any other fresh-water group examined by them in Central France, and have so much the aspect of the most ancient secondary rocks, that the presence alone of fluviatile and lacustrine shells, with Gyrogonites, compelled them to recognise the comparatively recent date of the whole group

This notice was accompanied by observations on the fossil insects mentioned in the preceding memoir, by John Curtis, Esq., F.L.S. These insects are all of European forms, and are most of them referrible to existing genera. The greater portions belong to the orders Diptera and Hemiptera; the Coleoptera are next in number, there are only a few Hymenoptera, and there is but one Lepidopterous insect. "As a larger collection," says Mr. Curtis, "might greatly change the proportion of the different orders, no positive inference, as to climate, should be drawn from the present assemblage; but there is nothing in the character of the insects to warrant the supposition of a higher temperature than that of the South of France." The greater portion of these remains were very probably brought together from different localities by floods, mountain-torrents, or rivers; yet there

there is no insect among them that might not be found in a moist wood. The antennæ, tarsi, and other parts by which the characters would be best distinguished, are often wanting; yet enough characters frequently remain even then to distinguish the genus. The sculpture, and even some degree of colouring, are preserved in several specimens. The wings of some beetles are extended beyond the elytra, showing that when they perished, they were flying, or attempting to escape by flight.

A collection of fossil vegetables, from the Northumberland and Durham coal-field, was exhibited at this meeting, and presented to the Society by William Hutton, Esq., of Newcastle-upon-Tyne, F.G.S.; with a catalogue describing the plants, according to the systems of M. Ad. Brongniart and Mr. Artis. The collection consisted of specimens of Calamites, Sagenaria, Filicites, Myriophyllites, Asteriophyllites and Sphænophyllites.

At the close of this Meeting, which terminated the session, the Society adjourned till Friday evening the 6th of November.

ROYAL ACADEMY OF SCIENCES OF PARIS.

August 4, 1828.—The Minister of the Interior sent the ordonnance of the King, by which the Academy was authorized to accept the legacy of the fine library left by the late M. Gallois.—M. Richard Vaux, of Toul, sent a memoir on nervous action.—M. Guilbert announced his discovery of an instrument, by the assistance of which the size of stones contained in the bladder might be ascertained.—M. Bussy deposited a sealed packet.

A commission consisting of MM. Vauquelin, Thenard, the Duke of Ragusa, Cordier, and Beudant, made the report desired by the Minister of War, respecting M. Longchamp's theory of nitrification. This report, which was very long, was terminated by the following conclusions, which were adopted by the Academy.

1st. As to the theoretical part, we find that M. Longchamp has expressed an idea long since announced, namely, that nitric acid is formed without the assistance of animal matter; but the facts which he has cited are not sufficient to establish it with certainty. We find also that the assertion which he has made, that nitric acid is formed entirely by the elements of the atmosphere, is not correct; for it has been demonstrated that animal matter has great influence on this formation.

2dly. With respect to œconomical considerations, we see nothing in the opinions of M. Longchamp which gives us any hope of obtaining nitre at a cheaper rate, even supposing it to be produced in the manner which he imagines. If new experiments are to be made, it ought to be done under less favourable circumstances, that is to say, without the assistance of those materials which are acknowledged to possess great influence, and without which we do find nitrates formed in our establishments. We are of opinion that theoretical considerations only would induce a repetition of the experiments proposed by M. Longchamp. It would certainly be a curious fact in science, to find that nitric acid is formed under the circumstances indicated by this chemist.

 The

The Academy heard a memoir by M. Gerdry, on the mechanism of the walk of man; and a work by M. Vernière, containing therapeutic processes applicable to all cases of poisoning. The sections of botany and rural œconomy, afterwards presented, *ex æquo*, MM. Mirbel and Du Petit-Thouars, as candidates for the chair of rural œconomy, vacant in the Jardin du Roi, by the death of M. Bosc.

In this sitting M. Raspail addressed another letter on the subject of what he had written respecting the microscopes of M. Amici.

August 11.—Dr. Lusardi sent a memoir intitled *Histoire de l'Opération de la Cataracte, et parallèle des procédés mis en usage jusqu'à nos jours.*—M. Huzard, jun. presented a manuscript work *Sur les Haras de France.*—The Academy elected M. Mirbel in the room of the late M. Bosc.—M. Bertrand-Geslin read a memor intitled, *Considérations Géognostiques Générales sur le Terrain de Transport en Italie.*—M. Flourens read a memoir of experiments on the semicircular canals of the ears of birds.—M. Cagniard-Latour presented a summary of a memoir on the action of whistling in man.—M Moreau de Jonnès communicated Recherches de Géographie Botanique sur le Maïs.—A notice respecting the variation of the barometer by M. Malbec was read.

August 18.—An ordonnance of the King was read, approving the nomination of Dr. Serres, as a member of the Academy.—M. Dard sent a letter on the determination of the longitude at sea.—M. Grégoire presented a memoir on the theory of colours.—M. Griffith sent an account of experiments on the circular motion of certain bodies.—The Academy received two sealed packets: one from M. Cauchy; the other from MM. Pinot and Fermin.—M. Pouillet read a memoir on the measure of electric currents, and on a method of determining the intensity of terrestrial magnetism.

August 26.—The following manuscript works were presented: Description of an instrument for drawing in perspective, by M. Favret de Saint-Mesmin;—A letter on the decomposition of water by perchloride of cyanogen, by M. Sérullas;—A letter respecting an instrument for determining the size of a stone in the bladder, by M. Guilbert;—Researches on the circulation, respiration, and reproduction of the branchiferous annellida, by M. Dugu, of Montpellier.—M. Geoffroy announced that satisfactory news had been received of the expedition commanded by M. Durville.—M. Dumeril gave a verbal account of a work by M. Piorry, intitled, *De la Percussion Médiate, et des Signes obtenus à l'aide de ce nouveau moyen d'exploration dans les maladies des organes thoraciques et abdominaux.*—M. Du Petit-Thouars read a memoir on the origin of bark and of wood.—M. Girou continued the reading of his memoir on the reproduction of domestic animals.—M. Ampère read a memoir on the determination of the curved surface of luminous waves, &c.

Sept. 1.—The Minister at War thanked the Academy for its report respecting artificial nitre beds.—There were read a memoir on railroads by M. Masquelet;—On cyanic acid by M. Sérullas;—On the velocity of light, &c. by M. Ampère.—M. Chevreul, in the name of a commission, gave a favourable account of M. Raymond's memoir on the

the dyeing of wool by means of Prussian blue ;—M. Boyer gave a favourable report also respecting M. Delpech's paper on the *Résection* of the lower jaw.—M. Moreau de Jonnès continued the reading of his memoir on geographical botany.—The Academy, in a secret committee, agreed to the dedication of M. Brué's new geographical atlas.

Sept. 8.—M. Baudelocque, nephew, announced two new processes in uterine hæmorrhages and affections of the womb.—M. Marc Jadot sent a geographical table containing the laws of the population of France and of the city of Paris.—M. Say sent some reflections on the relations of the exact sciences with political œconomy.—M. Chevreul read a memoir on the fatty matter of wool.—M. Geoffroy Saint-Hilaire read considerations on the vision of the mole.—M. Mirbel gave a verbal account of the first Number of MM. Durville and Lesson's work on cryptogamous plants.

Sept. 15.—Several letters were read from MM. Durville, Quoy, and Gaymard. These travellers announced a great number of drawings and descriptions of animals.—M. Cuvier read a favourable report respecting the experiments of M. Flourens.—M. Maurice gave a favourable account of M. Liouville's memoir, on dynamic electricity in general, and particularly on the mutual action of the pole of the magnet and a conducting wire.—M. Sérullas read a memoir On the action of sulphuric acid on alcohol, and the resulting products.

XXIII. *Intelligence and Miscellaneous Articles.*

DECEASE OF DR. YOUNG AND SIR HUMPHRY DAVY.

IT is our melancholy duty to record the loss of two of our most distinguished cultivators of science, Dr. Thomas Young, and Sir Humphry Davy: Dr. Young died in London on May 10th, and Sir H. Davy, at Geneva, on May 29th. The most important of the discoveries and contributions to science of both, have been from time to time recorded or inserted in the Philosophical Magazine; and we have commenced the present Number with the last production of Sir H. Davy, A paper on the Electricity of the Torpedo.

SPONGY PLATINA.

M. Pleischel recommends that a piece of paper be imbibed three times in succession with a solution of muriate of platina, and then burnt. The residue is the platina, he says, in its best state for effecting ignition. We have always found that, when prepared by heating a little pure ammonio-muriate of platina upon platina foil in a spirit-lamp, at a temperature as low as possible, so that it be sufficient to dissipate every thing volatile, then the platina would inflame a mixture of oxygen and hydrogen at the lowest possible temperature. —*Royal Instit. Journal,* April 1829.

INDELIBLE INK: BY M. BRACONNOT.

Dissolve 20 grammes of Dantzic potash in a sufficient quantity of boiling water, add 10 grammes of animal matter, such as the parings of

of tanned skins, and 5 grammes of flower of sulphur; boil the whole to dryness in a cast iron vessel; afterwards heat the matter strongly and stir it continually until it softens, taking care that it does not burn; then having gradually added a small quantity of water, filter it through a coarse cloth. A deep coloured liquor runs through, which may be kept for any length of time in a bottle, but it must be kept well corked; a single pen-full of this ink is sufficient to write one or two quarto pages, and it possesses all the properties which can be expected in an indestructible ink; it flows much better than common ink, and does not clog the pen by any substances held in suspension; it also resists the most powerful chemical agents, as will presently appear.

A strip of paper written upon with this solution, was treated with a boiling solution of potash, and was almost entirely destroyed; but the portions of paper remaining undestroyed, exhibited the writing perfectly. Paper written upon with the same solution, immersed for an instant in moderately strong sulphuric acid, was partly dissolved, being converted into a glutinous substance; but upon the undissolved portions, though rendered very thin, the writing remained legible.

Concentrated nitric acid had no effect upon writing with this ink in twenty-four hours, at a temperature below that for the complete destruction of the paper.

Another piece of paper written upon with the same ink, was immersed for some time in a strong solution of chloride of lime, mixed with muriatic acid, and it was afterwards put into a solution of potash for twenty-four hours; after this it was boiled to dryness, and then dissolved in water, when only a small portion of paper remained, but upon this the letters were very distinct.

M. Braconnot is of opinion that this solution may be advantageously employed in dyeing chesnut browns upon cotton, linen, and silk, or for darkening other colours.—*Annales de Chim. et de Phys.* Feb. 1829.

M. Braconnot has published a notice in the *Annales de Chimie* for April, in which he states that this ink is not so indestructible as he at first imagined, for it was destroyed by successive digestions in chlorine and potash.

PREPARATION AND COMPOSITION OF SOME BROMIDES, BY M. HENRY, JUN.

PERBROMIDE OF IRON.

Take a quantity of pure bromine, and put it into a porcelain capsule, containing about twenty times its weight of distilled water, and add gradually, and stirring with a brass rod, iron filings until the liquor ceases to emit bubbles; it is then to be gently heated, and when it has acquired a greenish tint it is to be filtered. The solution contains protobromide of iron, which is precipitated white by potash like the protosalts of iron, emitting a very peculiar smell; then evaporate to dryness by exposure to the air. The residual mass is of an orange red colour; treated with water it does not entirely dissolve, there remain some portions of peroxide of iron derived

derived from the peroxidation of a small portion of the iron of the protobromide. When again evaporated, the red matter yields a deposit of a similar red colour, rather more of a brick red, which strongly attracts moisture from the air, and is soluble in alcohol; when treated with sulphuric or muriatic acid, white acid vapours are disengaged.

It is composed of	Iron	15·27
	Bromine	84·73
		100

BROMIDE OF MAGNESIUM.

An excess of calcined magnesia was added to a solution of protobromide of iron, and slightly boiled. The filtered liquor when evaporated to dryness yielded crystals, which when purified by solution, and dried in a stove, were small acicular prisms, very soluble both in water and alcohol, deliquescent, of a bitter sharp taste, and precipitated in a flocculent state by ammonia, and by heat decomposed into acid and base.

It is composed of	Magnesium	7·760
	Bromine	92·240
		100

BROMIDE OF CALCIUM.

The bromide of iron was decomposed by hydrate of lime; the liquor was filtered when the precipitate was become brick red.

Bromide of calcium is very deliquescent, fuses into a whitish mass, and gives out a peculiar smell which has some resemblance to that of bromine, a small quantity of it appearing to suffer decomposition. This bromide crystallizes in acicular crystals, which are very soluble in water and alcohol; its taste resembles that of chloride of calcium. Sulphuric acid disengages a white vapour of hydrobromic acid, and towards the end, reddish vapours of bromine and sulphurous acid. When analysed by means of neutral oxalate of soda, it yielded such a quantity of oxalate of lime as showed that its composition was

Calcium	11·974
Bromine	89·026
	100

BROMIDE OF BARIUM.

Protobromide of iron was boiled with an excess of moist carbonate of barytes; when the precipitate became red, the liquor was filtered, evaporated, and calcined. The product, re-dissolved in pure water and carefully evaporated, yielded white rhombic prismatic crystals, slightly deliquescent, soluble in water and alcohol, disagreeably bitter in taste, undecomposable by heat, and giving with sulphuric acid, at first thick white vapours, and thin reddish vapours. When treated with sulphuric acid, it yielded such a proportion of sulphate of barytes as indicated its composition to be

Barium	31·75
Bromine	68·31
	100·06

The

The bromide of barium when dissolved, serves for preparing by double decomposition the bromides of magnesium and zinc, by employing the sulphates of these bases.

BROMIDE OF POTASSIUM.

This is prepared by decomposing protobromide of iron with carbonate of potash; when the saturation is perfect, the mixture is to be heated in the air to facilitate the peroxidation of the iron; the solution is to be filtered and evaporated, and by one or two crystallizations the pure bromide is obtained.

This salt crystallizes very well in cubes; it has a slightly saline taste, is slightly alterable by exposure to moisture, is soluble in alcohol, is decomposed by sulphuric acid, like the bromides of calcium and barium, and fuses without decomposing. When decomposed by sulphuric acid and heat, a portion of sulphate of potash was obtained, which showed it to be composed of

Potassium	26·548
Bromine	73·452
	100

BROMIDE OF SODIUM.

Obtained as the last, substituting carbonate of soda for that of potash. This bromide crystallizes very well in groups of small acicular crystals, of a whitish colour. It slightly attracts moisture by exposure to the air; its taste is rather alkaline than saline, and it is very soluble in water and alcohol.

It is composed of	Sodium	13·38
	Bromine	86·62
		100

Journ. de Pharmac. Feb. 1829.

PROTOBROMIDE OF MERCURY.

Pour a neutral solution of bromide of potassium, calcium, or magnesium, &c., into a very dilute solution of protonitrate of mercury; an abundant flocculent precipitate is formed, which is of a yellowish white colour: when this is carefully washed, and dried in the shade, the residue may be volatilized by a strong heat, and it condenses in the state of an acicular crystalline mass, which is of a yellowish colour while hot, but becomes whiter on cooling. It fuses like the protochloride and perchloride of mercury. Reagents, such as potash, soda, and the hydrosulphurets, precipitate this bromide in the state of mercurial protosalts.

It is probably composed of	Mercury . .	57·36
	Bromine . .	42·64
		100

PERBROMIDE OF MERCURY.

This compound may be prepared directly as proposed by M. Balard, by treating mercury with bromine, and subliming, or by decomposing persulphate of mercury with very dry bromide of potassium with

with the assistance of heat; equal quantities, sublimed with a strong heat, yielded a substance which was crystalline on the inner surface, and of a yellowish white colour; it was partly soluble in water, and contained some insoluble protobromide. It may also be prepared by heating equal quantities of bromine and mercury under water. The mixture becomes pasty, and by evaporating the fluid, silky needles of perbromide are formed. Or the evaporation may be continued to dryness, and the residue sublimed: when purified by sublimation, it has the form of very fine silky needles, which are very soluble, have a penetrating smell and are very volatile. It is precipitated yellow by potash, and red by chromate of potash.

It is composed of	Mercury	59·47
	Bromine	46·53
		100

All the bromides above described readily give out bromine by the action of chlorine.

ATOMIC CONSTITUTION OF CYANIDE OF MERCURY.

Mr. J. F. W. Johnston, M.A., who supposed he had discovered that clorine is evolved, when carbonate of manganese is treated with diluted sulphuric acid, has published a memoir in Dr. Brewster's Journal for the last month, the object of which is to "determine by experiment the atomic constitution" of cyanide of mercury.

Mr. Johnston admits that the constituents of the compound in question have been "correctly made out;" and if this be the case, we would inquire whether experiment can go further? To us it appears, that when the analysis of a compound has been performed, theory is to determine its atomic constitution. Thus, Dr. Henry and Dr. Thomson agree, that the red oxide of copper consists of 64 copper, 8 oxygen; but while the former chemist considers it to be a compound of one atom of each of its elements, the latter regards it as constituted of two atoms of copper and one atom of oxygen.

An examination of various authors would also have saved Mr. Johnston the trouble of an analysis; for he might have seen, that the conclusion at which he has arrived, that the compound in question is a bi-cyanide, but which he supposes is "nowhere to be found," is to be met with in the following authors: Mr. Brande, Manual of Chemistry, 1819, p. 306; Mr. Brande, Tables of Definite Proportionals, 1828, p. 63; Dr. Paris, Medical Chemistry, 1825, Appendix; Dr. Henry, Elements of Chemistry, 1826, vol. ii. p. 664; Dr. Turner, Elements of Chemistry, 1828, p. 519. R. P.

CARBAZOTATES OF COPPER AND LEAD.

M. Liebig finds that carbazotate of copper crystallizes in long rhombic needles, of an emerald green colour. They are readily soluble in water, and losing water by exposure to the air they become yellow.

Carbazotate of lead explodes when struck between two pieces of iron. It may be used with the same advantages, and with less danger than fulminating mercury, for percussion guns.

A concentrated solution of carbazotic acid is precipitated by diluted

luted nitric acid; it possesses this property in common with urea; the acid may be separated from the precipitate by washing with water.—*Hensman's Repertoire*, January 1829.

ANALYSIS OF PLATINA ORES.—BY BERZELIUS.

Platina ore from Nischne Tagilsk in the Uralian mountains.—This ore is of a dark gray colour, and contains many magnetic grains, some of which possess poles, and the larger are capable of raising small pieces of steel wire. The magnetic and non-magnetic grains were separately analysed, and the results showed that they are essentially and constantly different.

	Non Magnetic.	Magnetic.
Platina	78·94	73·58
Iridium	4·97	2·35
Rhodium	0·86	1·15
Palladium	0·28	0·30
Iron	11·04	12·98
Copper	0·70	5·20
Osmiuret of iridium in grains	1·00	
——— in scales	0·96	
Insoluble matter		2·30
	98·75	97·86

The insoluble matter of the magnetic grains was a mixture of osmiuret of iridium in grains and scales, with some sand.

Platina ore from Goroblagodat in the Uralian mountains.—This ore is remarkable on account of its being entirely non-magnetic, and because it contains no iridium, except that a trace of it was found in one specimen.

Platina	86·50
Rhodium	1·15
Palladium	1·10
Copper	0·45
Iron	8·32
Osmiuret of iridium	1·40
	98·92

In these three analyses a part of the loss consisted of osmium, which distils during the solution in the acid.

Platina ore from Barbacoas in the province of Antioquia in Colombia.—This ore consists of grains which frequently weigh nearly a gramme (15·4 grains), mixed with a smaller quantity of smaller grains. The larger grains consisted of

Platina	84·30
Rhodium	3·46
Iridium	1·46
Palladium	1·06
Osmium	1·03
Copper	0·74
Iron	5·31
Quartz	0·60
Lime	0·12
	98·08

Annales de Chim. et de Phys. April 1829.

ROSACIC ACID IN HUMAN URINE.

M. Henry, Jun., during an attack of acute rheumatism, accompanied with nervous fever, observed that his urine became of a red colour, and on cooling, that it deposited a very abundant orange precipitate. On examination he found that it contained much rosacic acid, phosphoric acid, and phosphate of lime, but that the uric acid had disappeared and been replaced by the rosacic acid.—*Journal de Pharmac.* xv. p. 228.

SILICATE OF IRON FROM BODENMAIS.

Professor Kobell of Munich reduced this ore to fine powder, and acted upon it with muriatic acid, and it yielded nearly

Silica	31·28
Peroxide of iron	50·86
Water	19.12
	101·26

It is therefore to be considered as an hydrated silicate of iron.—*Annales de Chim. et de Phys.* April 1829.

CALCAREOUS CRYSTALS IN THE TISSUES OF LIVING VEGETABLES.

M. Raspail, in a late memoir, shows that the crystals of the pandani, orchides, scillæ, &c., in short, all those which are about $\frac{1}{10}$th of a millimetre in length, and $\frac{1}{100}$th in breadth, are hexahedral crystals of phosphate of lime; and that the crystals of the tubercles of the iris, which are $\frac{1}{3}$rd of a millimetre in length, and $\frac{1}{10}$th in breadth, are rectangular crystals of oxalate of lime. It was by means of a magnifying power of from 1000 to 2000 diameters that these new researches were established. These crystals, it will be remembered, were taken for microscopic hairs; and very recently an author imagined he saw them perforated in the middle of their length, and figured them as such.—*Jameson's Journal,* July 1829.

CHLORIDE AND IODIDE OF AMMONIA.

M. Sérullas has announced to the French Academy, that the substances usually termed chloride and iodide of azote contain hydrogen; or in other words, that they are chloride and iodide of ammonia.—He has promised a memoir on the subject.—*Le Globe,* April 11th & 18th.

DECOMPOSITION OF AMMONIA BY METALS.

M. Despretz, who first announced that metals when subjected to heat and ammoniacal gas, underwent a considerable change of density, has also discovered that the weight of iron is sometimes increased as much as $11\frac{1}{2}$ per cent, owing to its combining with azote; but if the heat be too great, then the azote is again expelled.—*Ibid.* April 11.

ANALYSES OF BATH WATER AND OF TWO MINERAL SPRINGS IN WINDSOR FOREST.

Mr. Walcker of the Brighton German Spa finds that an imperial pint of Bath water contains

Chloride of sodium	1·89031	grains
——— magnesium	1·66741	
Sulphate of potash	0·36588	
——— soda	2·42145	
——— lime	10·20303	
Carbonate of lime	1·33339	
Protocarbonate of iron	0·03012	
Alumina	0·01885	
Silica	0·40419	
Extractive matter	a trace	
	*18·33496	

Carbonic acid gas } at 114° temp. { 0·05 cubic inch
Atmospheric air } at 114° temp. { 1·74 do. do.

With respect to the mineral springs in Windsor Forest, it is stated that Captain F. Forbes of Winkfield-place, Windsor Forest, discovered them some time ago on his estate: one, the analysis of which is stated under A, in the immediate neighbourhood of his mansion; the other, mentioned under B, at some distance. Both these mineral springs, belonging to the magnesio-saline class, have since been used by a great number of patients; and the good effects which have been observed from their use have induced Captain Forbes to build a pump-room for the accommodation of the public.

A pint of the waters contains as under:

	A	B	
Carbonate of lime	6·0630	8·2507	grains
Sulphate of lime	9·8904	8·3064	
——— potash	1·3549	1·1382	
——— soda	15·5779	17·1761	
——— magnesia	20·8704	21·1920	
Nitrate of magnesia	2·6551	traces	
Chloride of magnesium	19·6909	26·3169	
Silica	0·5033	0·9210	
Alumina	0·5721	0·3938	
Extractive matter	traces	traces	
*	77·1780	83·6951	
Carbonic acid gas } at 51° at the temp.	2·786	3·306	cubic inch.
Atmospheric air } of the wells	0·611	0·658	do. do.
Specific gravity at 60° Fahr.	1·00737	1·00897	

Royal Institution Journal, April 1829.

ERRATUM IN MR. EWART'S PAPER, APRIL LAST, P. 254.

Line 17, *for* low pressure *read* low temperature.

ON

ON SODIUM: BY M. SERULLAS.

If potassium is put on a mercury bath, the fragments remain for some time motionless; they afterwards, during amalgamation, begin a movement, which gradually increases and becomes very rapid. This movement depends upon the absorption and decomposition of the moisture of the atmosphere by the metal, from which results the evolution of hydrogen, which occasions the movement; when potassium is placed in contact with mercury under a receiver containing dry air, the amalgamation goes on quietly.

If on the other hand a particle of sodium be quickly thrown upon mercury, it is violently projected out of the bath, occasioning a slight explosion, accompanied with heat and light. MM. Gay Lussac and Thenard have already observed that during the amalgamation of sodium, heat and light were given out. It is also well known that potassium burns in contact with water, while sodium decomposes it without combustion.

Thus the distinguishing characters of sodium and potassium are, that the first combines with mercury with heat and light, and the other merely with heat; that sodium decomposes water without burning, and that potassium under similar circumstances occasions vivid light. It will be observed that in these two cases, each metal possesses opposite properties. The last-mentioned effect is owing to the greater heat occasioned by potassium, which even reaches incandescence, while with sodium the heat is not sufficient to occasion inflammation. The proof of this will be found in the following experiment, by which sodium may be made to burn by the contact of water.

Make a moderately strong mucilage of gum-arabic, and the sodium when thrown upon it readily inflames. The fragments are retained by the density of the liquid, and fixed to a point, and then become sufficiently hot to ignite, and run over the surface of the liquid in the same manner as potassium. The flame is yellowish instead of bluish, as with potassium. This effect cannot be produced upon water or a moistened body, which by its nature abstracts the heat produced by the decomposition of the liquid. Indeed if a piece of sodium be fixed upon a piece of wood or other bad conductor, and then touched with a drop of water or two, it inflames and flies immediately; but this effect is not produced upon glass or porcelain.

GEOLOGICAL ARRANGEMENT OF BRITISH FOSSIL SHELLS.

In the sixth Number of the *Magazine of Natural History*, Mr. R. C. Taylor has published a series of approximate stratigraphical tables of British fossil testacea; forming an abstract of a more extended index, constructed chiefly from Sowerby's *Mineral Conchology*, and from authentic details, after essential corrections in the localities and formations. These tables exhibit the geognostical distribution of about thirteen hundred species; and, from the caution employed in constructing them, this is probably considerably short of the actual number known to collectors.

Mr. Taylor deduces various interesting results from his investigations,

tions, a brief view of which we proceed to state, nearly in his own words. The following series of fossil shells are known to English naturalists :—

Simple univalves	58 genera, which comprise	401 species.
Simple bivalves	62	583
Complicated bivalves	3	51
Multilocular bivalves	12	230
	135	1265

On making three principal divisions of the formations containing organic remains, and enumerating the shells they respectively contain, we have these results :

The *first*, which is also the lowest or most ancient division, may be subdivided into two series of formations.

1. Carboniferous order of Mr. Conybeare.		2. From the carboniferous to the lias, inclusive.
Species 27	Simple univalves	9 species.
34	Simple bivalves	33
46	Complicated bivalves	5
33	Multilocular univalves	50
140		97

The *second*, or middle, division, from the lias upwards, includes the entire oolite series, and the strata up to the chalk, inclusive.

Simple univalves	106 species.
Simple bivalves	375
Complicated bivalves	0
Multilocular univalves	139
	620

The *third*, or most recent, division, comprises all the beds above the chalk, or the tertiary formations.

Simple univalves	259 species.
Simple bivalves	141
Complicated bivalves	0
Multilocular univalves	8
	408

The numbers of each of the four classes of shells which existed during separate periods or geological intervals, are as follows :

First Division. Ancient strata, including lias			Second and Third Divisions Remaining strata, above the lias, up to diluvium.	
	Species 36	Simple univalves	365 species.	
	67	Simple bivalves	516	
134	51	Complicated bivalves	0	147
	83	Multilocular univalves	147	
	237		1028	

Here the number of complex species in the first division is nearly equal to those in the immense series of succeeding strata, 134 being peculiar to the lowest, and 147 to the remainder. But the individuals are greatly more numerous in the older strata than in the later, and give a more decided character to those formations than appears from a comparison of genera or species; and the class of complicated bivalves is wholly limited to this older division. The difference is yet more striking when we compare the first with the third division; the simple univalves in the former being to those in the latter in the proportion

portion of 1 to 7; but the complicated species, in the same divisions, are in the reverse ratio nearly of 17 to 1.

On comparing the proportions which the classes of shells under each division bear to each other, differences equally remarkable are observable. Thus the univalves in the first division are to the complex species as 1 to 4; in the second, as 1 to 1⅓rd only; and in the third, as 32 to 1.

The ancient formations are characterized by complicated shells, the middle series by bivalves, and the upper by simple univalves.

Mr. Taylor next illustrates from the Tables, Mr. Dillwyn's remarks on the distribution of carnivorous and herbivorous Trachelipodes. He shows that, in the English formations, the *Zoophages* comprise 22 genera, and 171 species. They may be considered as appertaining to, if not as wholly characteristic of the tertiary formations; and many of the genera are continued in our present seas. Of the *Phylliphages*, 22 genera and 168 species are distributed through the secondary and tertiary formations.

When the members of each of these classes are arranged according to the three geological divisions already mentioned, we find that the turbinated univalves of the older strata or rocks belong almost entirely to the herbivorous family, 12 genera having originated there, which have been perpetuated through all the successive strata, and still inhabit our waters; that in the middle series of formations, this preponderance of animals possessing similar habits was preserved; and that, in the last series, after the chalk was deposited, this order was suddenly reversed, in the proportion of 5 to 19.

Mr. Dillwyn observed that all the marine Trachelipodes, of the herbivorous tribes, in the ancient strata, are furnished with an operculum, seemingly intended as a protection against the Cephalopodes, or carnivorous order of Nautili, Ammonites, &c., which, at that time, abounded in the seas. After the epoch of the extinction of this order (which terminated chiefly with the chalk), numerous unoperculated genera appear, as if no longer requiring such a shield to protect them from an extinct enemy. As carnivorous turbinated univalves were almost entirely absent from the strata which contained the Ammonites, the Nautilidiæ, and the Belemnites, so the extinction of these immensely numerous tribes, being also carnivorous, or predaceous, was counterbalanced by the creation of a multitude of new genera, possessed of similar appetences.

Recurring again to our table for illustration of these positions, we observe that only 3 genera and 18 species of carnivorous turbinated univalves were coeval with the Cephalopodes, comprising 200 species, in the secondary formations; but that the same strata contained 17 genera and 87 species of Phylliphages.

When the Cephalopodes ceased with the chalk, at the same time with the numerous families of fossil Echinidiæ, the Trigoniæ, and nearly all the Terrebratulæ, they were replaced by 19 genera and 153 new species of Zoophages.

On comparing the existing classes of shells with corresponding

ing series in the antediluvian creation, we have the following numbers:

	Simple Univalves.	Bivalves and Multivalves.	Multilocular Univalves.	Total.
	Species	Species.	Species.	Species.
Testaceous Mollusca of the present world, ascertained from the *Index Testaceologicus* of Mr. Wood, last edition	1961	874	58	2893
Species of British fossil shells, heretofore described, dispersed throughout the entire range of the formations	401	634	230	1265

In the aggregates thus exhibited, there is an apparent want of conformity in the relative proportions of each class. This wholly arises from the extinct genera of the ancient strata; for, on making the comparison between the recent series and those of the latest group of deposits, no such difference will be perceived. On the contrary, a considerable agreement between the proportions of existing species and the several classes of fossil shells in the tertiary beds prevails; the average increase of numbers being about sevenfold.

If we follow the investigation further, we may observe that the fossil multilocular and complicated Testacea, which characterize the oldest formations, and decidedly preponderate in that end of the series, form one-fifth part of the entire catalogue; but, amongst the recent shells, this class constitutes less than a fortieth part, and in the tertiary series only a fiftieth part.

The conclusion to be drawn from a summary of facts more numerous, and on a more extended scale than, until recently, has been attainable in this department of natural history, is, that in proportion as we descend the vast series of deposits that overspread this portion of the earth, so do we recede, step by step, from the circle of existing organized beings, and from the phænomena attendant on their structure, their habits, and their adaptations.

NEW INVENTION FOR PROPELLING SHIPS, &c.

Mr. Charles A. Orth, of Charles-street, Hatton Garden, No. 12, requests us to state, that after the labour of five years he has succeeded in rendering fully effective a new method of propelling vessels of all descriptions against wind and tide. The power is obtained by the application of weight, the mechanism is very simple, and it affords any horse-power acquired. Mr. Orth wishes to confer upon the subject with any gentleman who may be interested in the improvement of mechanical navigation.

BROMINE AND BROMIDE OF POTASSIUM.

These curious substances, which we believe have not been hitherto prepared in this country, have been imported for sale by Messrs. Allen and Co. Plough-court, Lombard-street. We need, perhaps, scarcely add our opinion that the quality of the articles in question may be fully depended upon.—Edit.

ON THE VARIATION OF THE NEEDLE, AS OBSERVED DURING A VOYAGE TO AND FROM INDIA. BY W. H. WHITE, H.M.C.S.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

Not having seen any thing lately on the variation of the mariner's compass, and having just perused the private log of a gentleman recently returned from India, I have extracted a few observations, showing the variation at four nearly corresponding latitudes, outward and inward.

Outward bound.

Latitude.	Longitude.	Variation.
49° 30′ N.	5° 30′ W.	27° W.
10 S.	23 30 W.	10 W.
21 00 S.	37 00 W.	00
40 00 S.	31 00 E.	31 W.

Homeward bound.

Latitude.	Longitude.	Variation.
36° 30′ S.	23° 00′ E.	28° W.
21 30 S.	2 51 E.	20 W.
20 N.	18 25 W.	11 W.
49 40 N.	5 40 W.	25 W.

In the outward passage, it appears that the variation diminished as the latitude diminished and the longitude increased westward, till the ship reached latitude 21° S., longitude 37° W., when it entirely ceased. A progressive increase again took place as the ship continued to sail southward, making E. longitude.

In the homeward passage there is a regular diminution of variation as the ship sails westward; and as a proof that the compass is not influenced by latitude, at least in the torrid zone, we find in latitude 21° 30′ S. the variation was 20° W., whereas in 21° S. in the outward passage, having a difference of 39° 51′ W. longitude, there was no variation. Hence it appears as the ship increases in E. longitude from 37° W., the variation of the compass increases W., but to what extent I believe is not determined.

Should these observations be worthy of insertion in your scientific Journal, they may lead to a completion of facts that would highly benefit the science of navigation.

I am, Gentlemen, yours, &c.

Bedford, July 8, 1829. W. H. WHITE, H.M.C.S.

ACTIVE MOLECULES IN ORGANIC AND INORGANIC BODIES.

The peculiar and apparently inherent motion of these molecules discovered some time since by R. Brown, Esq. F.R.S.,* excites an increased interest in consequence of the difficulty of accounting for it satisfactorily. Mr. Holland, who has for some time closely applied himself to microscopic researches, has found that the motion continues equally vivid, when the liquid containing the molecules

* See Phil. Mag. and Annals, N.S. vol. iv. p. 161.

 is

is covered with a thin piece of talc: he was induced to try this experiment in order to ascertain whether the motion might not be the result of external causes acting upon the surface of the fluid. On the 29th of June last, he carried the experiment further, by sealing hermetically the whole circumference of the talc, in order to prevent evaporation, which (although ten days have elapsed) has not taken place; and yet there is not the slightest alteration either in the molecules or their motion, and (should the sealing be perfect) most probably none will occur: this experiment proves that evaporation is not the cause of the motion.

Mr. Cary, optician, 181 Strand, has the specimen in his possession, ready for exhibition to those who may feel an interest on the subject. Mr. Holland used No. 2 of the deep power sold by Mr. Cary, the sidereal focus of which is the 1-30th of an inch, with a linear magnifying power of 300: this power developes the phænomena connected with these molecules in a most satisfactory manner.

July 9, 1829.

LIST OF NEW PATENTS.

To H. R. Palmer, London Docks, for improvements in the construction of warehouses, sheds, and other buildings, intended for the protection of property.—Dated the 28th of April, 1828.—2 months allowed to enrol specification.

To B. Cook, Birmingham, for an improved method of making rollers or cylinders of copper and other metals, or a mixture of metals, for printing of calicos, silks, cloths, and other articles.—23d of April.—6 months.

To J. Wright, Newcastle upon-Tyne, for improvements in condensing the gas or gases produced by the decomposition of muriate of soda and certain other substances, which improvements may also be applied to other purposes.—28th of April.—6 months.

To P. Pickering, Frodsham, Cheshire, and W Pickering, Liverpool, merchants, for having invented an engine or machinery, to be worked by means of fluids, gases, or air, on shore or at sea, and which they intend to denominate Pickering's Engine.—28th of April.—6 months.

To J. Davis, Lemon-street, sugar-refiner, for a certain improvement in the condenser used for boiling sugar in vacuo.—28th of April.—6 months.

To G. W. Lee, Bagnio-court, Newgate-street, merchant, for certain improvements in machinery for spinning cotton and other fibrous substances.—2d of May.—6 months

To H. Bock, Esq. Ludgate hill, for improvements in machinery for embroidering or ornamenting cloths, stuffs, and other fabrics.—2d of May.—6 months.

To J. Dutton, junior, Wotton Underedge, Gloucester, clothier, for certain improvements in propelling ships, boats, and other vessels or floating bodies by steam or other power.—10th of May.—6 months.

To M. Dick, Irvine, Air, for an improved rail-road, and for propelling carriages thereon by machinery, for conveying passengers, letters, intelligence, packets and other goods, with great velocity.—21st of May.—6 months.

To

To T. R. Williams, Esq., Norfolk-street, Strand, for improvements in the manufacturing of felt, or a substance in the nature thereof, applicable to covering the bottoms of vessels, and other purposes.—23d of May.—6 months.

To T. Arnold, Hoxton, tin-plate worker, for an improved machine or gauge for the purpose of denoting the quality or strength of certain fluids or spirituous liquors, and for measuring or denoting the quantity of fluids or spirituous liquors withdrawn from the vessel in which the same are contained, and which machine or gauge may be so constructed as to effect either of the above objects without the other, if required.—26th of May.—6 months.

To W. Poole, St. Michael on the Mount, Lincoln, smith, for improvements in machinery for propelling vessels, and giving motion to mills and other machinery.—26th of May.—2 months.

To C. T. Sturtevant, Hackney, for improvements in the manufacturing of soap.—26th of May.—6 months.

To J. C. Daniell, Limpley Stoke. Bradford, Wilts, clothier, for improvements in machinery applicable to the dressing of woollen cloth.—26th of May.—6 months.

To R. Winans, Vernon, Sussex, State of New Jersey, North America, resident in London, for improvements in diminishing friction in wheeled-carriages to be used on rail and other roads, and which improvements are applicable to other purposes.—28th of May.—6 months.

To W. Mann, Gent, Effra road, Brixton, for having discovered that by the application of compressed air, power and motion can be communicated to fixed machinery, and to carriages and other locomotive machines, and to ships, vessels, and other floating bodies.—1st of June.—6 months.

To A. Gottlieb, Jubilee-place, Mile-end-road, for improvements on, or additions to, locks and keys.—1st of June.—6 months.

To J. Smith, Bradford, York, for improvements in machinery for dressing flour.—4th of June.—2 months.

To C. Brook, Meltham Mills, near Huddersfield, York, for improvements in machinery for spinning cotton and other fibrous substances.—4th of June.—6 months.

To R. Porter, Carlisle, Cumberland, for improvements in the manufacture of iron heels and tips for boots and shoes.—13th of June.—2 months.

To F. Day, Poultry, optician, and Auguste Munch, mechanic, of the same place, in consequence of a communication made them by a certain foreigner residing abroad, and inventions by themselves, for improvements on musical instruments.—19th of June.—6 months.

To C. Wheatstone, Strand, for improvements in the construction of wind musical instruments.—19th of June.—6 months.

To M. Poole, Gent., Lincoln's-inn, in consequence of a communication made to him by a certain foreigner residing abroad, for improved machinery for preparing or kneading dough.—19th of June.—6 months.

Results of a Meteorological Journal for 1827, *made by Mr.* W. B. BOOTH, *A.L.S. in the Garden of the Horticultural Society at Chiswick, near London.*

1827. Months.	Pressure.								Temperature.												
					Mean at				In the Shade.				Mean at				In the Sun's Ray.		Terrestrial Radiation.		
	Max.	Min.	Med.	Range of Barometer.	Morn.	Noon.	Night.	Mean of the three Observations.	Max.	Min.	Means of Extremes.	Real monthly Means.	Morn.	Noon.	Night.	Mean of the three Observations.	Max.	Min.	Max.	Min.	Med. of Sun and Rad.
	In.	In.	In.	In.	In.	In.	In.	In.	°	°	°	°	°	°	°	°	°	°	°	°	°
Jan.	30·403	29·226	29·814	1·177	29·910	29·897	29 927	29 911	53	12	32·5	35·06	35·10	39·68	35·19	36·65	62	32	44	5	35·78
Feb.	30 635	29·459	30·047	1·176	30·104	30·098	30·113	30·105	57	15	36·0	33·85	31·64	39 39	32 36	34 46	71	36	45	4	35·32
March	30·563	28·881	29·722	1·682	29·726	29 769	29·750	29 748	60	27	43 5	44·90	43 74	50·74	43·29	45·92	76	53	45	17	47·72
April	30·386	29 540	29 963	0 846	30 013	30·011	30·016	30·013	78	25	51·5	48 99	48·13	57·33	47·60	51·02	105	51	45	17	53·64
May	30·193	29·212	29·702	0·981	29·826	29·805	29·808	29 813	81	32	56·5	56 27	55·74	64·16	52·77	57·56	113	55	50	23	62·77
June	30·354	29·617	29 985	0·737	29 963	29·948	29·978	29 963	79	38	58 5	59·58	59·45	68·24	58·76	62·15	105	62	55	30	67·41
July	30·475	29·739	30 107	0 736	30·111	30·119	30·115	30·115	89	44	66·5	65·32	64·29	74 32	65·06	67·89	118	72	59	34	73·98
Aug.	30·452	29·363	29·907	1·089	30·033	30·040	30·033	30·035	86	42	64·0	60 90	60·10	69 03	60·97	63 37	112	68	57	32	68·45
Sept.	30·394	29·513	29 953	0·881	30·008	30·010	30 017	30·011	72	40	56·0	59·06	56·70	65·00	57·10	59 93	100	65	55	32	65·01
Oct.	30·549	29·022	29·785	1·527	29·782	29·782	29·787	29·783	67	31	49·0	52 82	50·45	59 64	50·64	53·58	93	46	50	24	57·41
Nov.	30·435	29·386	29·910	1·049	30·028	30·044	30·015	30·029	60	20	40·0	43 65	42 63	48·86	43·13	44·87	73	38	44	11	45·41
Dec.	30·729	29·042	29·885	1·687	29·873	29·880	29·874	29·875	58	27	42·5	44·66	43·16	49·06	44·16	45·46	65	37	48	19	44·79
Aver.	30·729	28·881	29·898	1·130	29·948	29·950	29·953	29·950	89	12	49·71	50·42	49 26	57·20	49·25	51·90	91·1	51·2	49·7	20·6	54 81

TABLE (*continued*).

1827 Months	Hygrometer indicating Dew Point. Mean Dew Point Morn.	Noon.	Night.	Mean of Morn, Noon, and Night	Mean Force of Vapour.	Mean Degree of Dryness	Mean Degree of Moisture	Least Degree of Moisture	Scale of the Winds. N	NE	E	SE	S	SW.	W.	NW.	Days.	Rain at the Ground in Inches, &c.
	°	°	°	°	Inch	°	°	°										
Jan	33 58	36 26	34 51	34 78	0 232	1 90	935	685	5	4	2	0	2	6	3	9	31	0 57
Feb.	28 64	30 78	30 96	30 12	0 200	4 33	862	550	8	3	8	2	3	0	2	2	28	0 79
March	42 13	43 90	42 64	42 89	0 304	3 03	894	504	2	0	0	0	2	6	14	7	31	2 50
April	45 66	47 76	46 40	46 60	0 352	4 40	850	425	1	6	1	6	6	6	2	2	30	0 71
May	52 10	51 87	51 97	52 98	0 428	4 69	842	508	0	1	5	5	6	13	1	0	31	2 24
June	55 48	55 93	54 72	55 37	0 460	6 76	797	414	0	5	3	1	5	8	4	3	29	0 82
July	59 39	58 06	58 64	58 69	0 526	9 19	752	420	0	1	3	2	3	9	8	5	31	1 31
Aug.	56 06	56 45	57 32	56 61	0 492	6 75	800	440	1	3	1	3	8	3	6	6	31	1 66
Sept	54 56	58 83	55 56	56 31	0 492	3 60	906	439	3	6	0	4	3	4	4	6	30	3 37
Oct.	49 80	55 35	49 84	51 66	0 414	1 91	932	774	1	2	5	10	4	2	6	1	31	4 06
Nov.	41 73	45 80	42 40	45 31	0 316	1 55	963	680	2	1	2	4	6	5	5	5	30	1 06
Dec	42 51	46 48	43 77	44 25	0 328	1·20	964	763	1	0	0	1	5	9	10	5	31	3 09
Aver.	46 80	49 20	47 39	47 79	0 378	4 11	874	550	24	32	30	38	53	71	65	51	364	22 18

The instruments used in this year's Journal are the same as those used the preceding year, and the same plan was adopted in recording the observations The only alteration that has been made in the position of the instruments, is the removal of the thermometer for ascertaining the temperature in the sun's rays, to a more suitable place in the Arboretum, and it is now placed on the grass about two inches from the ground. to obviate any increase of temperature in its indications, which would undoubtedly have occurred by means of the radiations from the nearness of the wall, and the mould over which it was first placed.

Note.—The accuracy and judicious arrangement of the instruments used, which are very essential to the purposes of meteorology, the able hands in which they are intrusted to register the observations, and the opportunities that will be afforded the observer in so eligible a situation, to ascertain the effects of heat or cold, wind, rain, and drought, on the various fruits and vegetation, will ultimately be found beneficial to the Horticultural Society, by the experience they will gain year after year in providing as much as possible for the preservation of those things against the vicissitudes of a very changeable climate.

METEOROLOGICAL OBSERVATIONS FOR JUNE 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·37 June 11. Wind N.E.—Min. 29·36 June 27. Wind S.E.
Range of the mercury 1·01.
Mean barometrical pressure for the month .... 29·998
Spaces described by the rising and falling of the mercury............ 3·450
Greatest variation in 24 hours 0·400 —Number of changes, 15.
Therm. Max. 76° June 3. Wind N.W.—Min. 42° June 6. Wind N.E.
Range 34°.—Mean temp. of exter. air 61°·02 For 31 days with ☉ in ♋ 61·51
Max. var. in 24 hours 24°·00—Mean temp. of spring-water at 8 A.M. 51°·76

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere in the morning of the 29th ... 86°
Greatest dryness of the atmosphere in the afternoon of the 5th ... 35
Range of the index 51
Mean at 2 P.M. 50°2.—Mean at 8 A.M. 55°6.—Mean at 8 P.M. 59·6
—— of three observations each day at 8, 2, and 8 o'clock .... 55·1
Evaporation for the month 4·35 inch.
Rain in the pluviameter near the ground 2·270 inch.
Prevailing wind, S.E.

Summary of the Weather.

A clear sky, 3; fine, with various modifications of clouds, 17, an overcast sky without rain, 6; rain, 4.—Total 30 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
26	16	29	0	24	22	17

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
2½	2½	2	8	2	4	3	6	30

General Observations.—The first part of this month the fruits and vegetation made but little progress in growth, from the want of moisture; but the wheat, which came into ear the first week, preserved a verdant and luxuriant appearance; it is now turning yellow, and will be fit for the sickle in this neighbourhood in three weeks, with genial weather: the last fortnight was contradistinguished by frequent intervals of warm showers of rain, the beneficial effects of which on the productions of the earth may be seen even by casual observers.

On the 1st instant distant thunder was heard here, and light showers fell at a distance. On the 3rd the thermometer in the shade rose to summer-heat, when it showed the maximum temperature for the month. Early in the morning of the 7th a very white hoar fros appeared in the grass fields, and was brought on by a cold N.E. wind under a clear blue sky, and a pretty high atmospheric pressure.

In the evening of the 9th a large halo appeared round the moon, and set with it, which indicated a humid change in the state of the atmosphere.

On

On the 13th a solar and a lunar halo appeared, and set with the sun and moon which they circumscribed. In the evening of the 16th, after another dry and dusty period of twenty-two days, very refreshing showers of rain came on by means of a change of wind to the S.W.; they were followed almost every day to the end of the month by gentle rain, and a tolerably uniform temperature.

On the 20th and 29th, lightning and thunder occurred by the inosculation of two currents of wind: and solar halos again presented themselves in beds of *cirrostratus* on the 23rd, 24th, 26th and 30th, and were followed by rain, mostly in the nights. The mean temperature of the atmosphere this month is nearly half a degree under the mean of June for many years past.

It would be difficult to describe with any degree of accuracy the richness and beauty of the colours that appeared in the clouds, and in the water about the shore here at sunrise and sunset in the early part of the month: the same gradation of colours which the condensed aqueous vapours and falling dews passed through at these times, was successively painted on the water beneath them, as yellow, orange, red, lake, light blue, &c.

The red light is remarkable for its frequency in the clouds; and in passing through a prism it appears the least refrangible of any other, and makes the strongest impression on the retina of the eye; it forces its way through very dense media; hence it is that we see through a fog the discs of the sun and moon red, and also distant terrestrial lights, as was the case on the 16th of last month.

The atmosphere a few miles high is permanently transparent and cloudless, where solar light neither suffers alterations in its colours, nor obstruction in its passage by aqueous vapours, and where it shows a cerulean tint of different shades from light to dark blue, according to the temperature and elasticity of the atmosphere at that height. These shades, unchanged in their transmission, penetrate the deep sea-water in high latitudes to some depth, and by strangers to marine views are looked upon with admiration, while the shallow water about the shores to some distance in the offing, preserves a varying green colour. The colours seen on the water are in the rays of light, not in the bodies that refract or reflect them. When wind and attenuated vapours prevail, the blue tint that appears on the water under an azure sky is changed to a variety of green shades, and even to a turbid colour, according to the density of the vapours above, and the quantity of solar light intercepted by them. A dark *nimbus*, for instance, has often the effect of producing a dark green on the sea-water, and other modifications of clouds produce other colours thereon, as they are coloured.

The atmospheric and meteoric phænomena that have come within our observations this month, are two lunar and six solar halos, two meteors, three rainbows, lightning twice, thunder three times, and two gales of wind; namely, one from the South-east, the other from the South-west.

REMARKS.

London. — June 1. Cloudy. 2—5. Very fine. 6. Fine. 7. Very fine. 8. Cloudy, with slight rain at night: fine. 9. Cloudy morning: very fine. 10—15. Very fine. 16. Cloudy. 17. Sultry, with some thunder at noon. 18. Sultry, with heavy thunder showers in the afternoon. 19. Very fine. 20. Very fine: rain at night. 21. Overcast: very fine. 22. Cloudy and wet: fine at night. 23. Very fine: rain at night. 24. Very fine. 25. Fine, with showers: heavy rain at night. 26. Very fine. 27. Rainy. 28. Sultry, with thunder showers. 29. Drizzly. 30. Rainy.

Meteoro-

Meteorological Observations made by Mr. Booth at the Garden of the Horticultural Society at Chiswick, near London; by Mr. Giddy at Penzance, Dr. Burney at Gosport, and Mr. Veall at Boston.

Days of Month, 1829.	Barometer. London. Max	London. Min	Penzance. Max	Penzance. Min.	Gosport Max	Gosport Min.	Boston 8½ A. M.	Thermometer. London. Max	London. Min	Penzance. Max	Penzance. Min	Gosport. Max.	Gosport. Min	Bost. 8½ A.M.	Wind. Lond.	Penz.	Gosp.	Bost.	Evap. Gosp.	Rain. Lond.	Penz.	Gosp.	Bost.
● June 1	30 279	30 233	30 30	30 25	30 26	30 21	29 74	67	44	63	52	73	49	54	NW	N.	NW.	calm	0 15	...	...	...	...
2	30 287	30 237	30 36	30 32	30 28	30 25	29 75	77	57	66	51	72	57	61	W.	N	W	NW.	·10	...	...	...	0 02
3	30 231	30 106	30 40	30 35	30 25	30 16	29·55	82	59	69	54	76	59	65	W.	NW	NW.	W	15	...	...	...	...
4	30 119	29 974	30 20	30 18	30 11	30 01	29 53	76	54	67	55	73	59	58	W.	NW	W.	calm	10	...	...	...	·03
5	30 178	29·956	30 15	30 15	30 07	29 98	29 43	69	42	63	56	65	48	54 5	N	N	NW	NW.	15	...	...	...	...
6	30 294	30 210	30 25	30 20	30 22	30 20	29 76	61	37	63	49	62	42	49	NW.	N.	N.	NW	20	..	...	...	...
7	30 364	30 357	30 35	30 30	30 32	30 29	29 91	64	42	63	48	62	49	52 5	NE	NE	NE.	E	20	...	..	...	...
8	30 362	30 346	30 40	30 40	30 31	30 30	29 80	60	44	65	51	64	48	53 5	NE	NE	NW.	E	05	04	..	...	...
☽ 9	30 365	30 297	30 40	30 38	[illegible]	[illegible]	2[illegible] 90	60	41	69	5[illegible]	66	46	56	NE.	NE.	NE.	E	20	..	..	...	·03
10	30 383	30 369	30 38	30 38	[illegible]	[illegible]	2[illegible] 94	70	37	67	55	[illegible]	47	58 5	N	SE	NE	E	25	...	..	...	...
11	30 418	30 339	30 40	30 40	30 37	[illegible]	[illegible]	[illegible]	46	57	[illegible]2	70	52	61	NE	NE	SE	E	20	.	..	...	...
12	30 364	30 310	30 40	30 38	[illegible]	[illegible]	[illegible]	79	44	70	56	6[illegible]	[illegible]	61	W.	NW	SE	E	10	..	...	...	...
13	30 300	30 242	30 38	30 34	[illegible]	30 21	29 [illegible]2	[illegible]	[illegible]	[illegible]		[illegible]	55	6[illegible] 5	SW.	NW	SE	calm	15	.	..	...	...
14	30 225	30 124	30 30	30 18	30 [illegible]	30 1[illegible]	29 60	[illegible]	49	64	5[illegible]		55	6[illegible]	S	NW	W	calm	20	.	..	...	17
15	30 104	29 980	30 08	29 90	30 1[illegible]	[illegible]	29 [illegible]4	7[illegible]	50	7[illegible]	56		5[illegible]	65	S	SW	SW.	W	15	..	..	...	...
16	29 848	29 794	29 85	29 85	29 82	29 82	29 21	62	39	6[illegible]	51	6[illegible]	[illegible]	56 5	SW	W.	NW	W	·05	02	0·175	0 160	...
○ 17	29 867	29 816	29 90	29 85	29 82	2[illegible] 2	29 3[illegible]	70	48	[illegible]3	50	63	[illegible]		W	W	W	W	20	01	125	·055	...
18	30 036	29 859	30 05	30 00	29 95	29 [illegible]	[illegible]	69	4[illegible]	6[illegible]	[illegible]	68	49	[illegible]6	NE	NW	NW	[illegible]	15	07	..	050	·23
19	30 030	29 948	29 90	29 80	30 00	29 00	[illegible]	[illegible]	48	[illegible]	51	[illegible]1	57	[illegible]5 5	[illegible]	SW		W	20	...	·175	...	·39
20	29 921	29 751	29 70	29 60	29 80	29 [illegible]8	29 36	76	[illegible]8	65	55	69	5[illegible]	66 5	S		S	W	20	13	·440	·370	...
21	29 810	29 774	29 60	29 55	29 77	29 72	29 22	74	53	66	53	[illegible]	58	6[illegible] 5	SE.	SW	S	SW	13		075	...	·26
22	29 826	29 794	29 58	29 55	29 75	29 74	29 25	66	5[illegible]	67	57	[illegible]	5[illegible]	[illegible]3	S.	[illegible]	SE	S	17	·17	050	·050	·03
23	29 959	29 887	29 75	29 72	29 91	29 85	29 33	[illegible]	54	68	54	72	54	66	SW	SW		S	25	20	·500	·010	·38
☾ 24	30 074	29 994	29 90	29 85	30 02	30 00	29 40	77	49	68	56	74	56	65 5	SW.	S	SE	S.	20	...	·065	...	·26
25	30 056	29·924	29 95	29 90	30 00	29 90	29 46	77	56	70	56	73	5[illegible]	67 5	E	S.	E	S	10	38	255	·320	...
26	29 935	29·836	29 90	29 75	29 88	29 73	29 24	76	57	69	54	71	[illegible]	66	S	SW.	SE	W	10	·19	·130	·350	...
27	......	......	29 50	29 50	29 57	29 36	29 03		.	66	57	52	58	64	S	SE.	SE	SE	05	80	·320	·150	...
28	29 479	29 420	29 65	29 50	29 50	29 36	28 94	[illegible]	53	56	54	72	52	5[illegible]	NW.	N	E	NE	05	·08	1·870	·440	·51
29	29 740	29·685	29 73	29 75	29 70	29 60	29 20	60	49	67	54	63	53	5[illegible] 5	NW.	W	N	N	05	06	·070	·055	·53
30	29 748	29 703	29 72	29 70	29 70	29 70	29 21	70	55	65	56	67	57	58 5	S	S	S.	NW.	10	22	230	·260	·15
Aver.	30 418	29 420	30 40	29 50	30 37	29 36	29 49	84	37	70	48	76	42	60·3					4 35	2 37	4 480	2 270	2 99

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

SEPTEMBER 1829.

XXIV. *Additional Remarks on Active Molecules.* *By* ROBERT BROWN, *F.R.S., Hon. M.R.S.E. & R.I. Acad., V.P.L.S., Corresponding Member of the Royal Institutes of France and of the Netherlands, &c. &c.**

ABOUT twelve months ago I printed an account of Microscopical Observations made in the summer of 1827, on the Particles contained in the Pollen of Plants; and on the general Existence of active Molecules in Organic and Inorganic Bodies.

In the present Supplement to that account, my objects are, to explain and modify a few of its statements, to advert to some of the remarks that have been made, either on the correctness or originality of the observations, and to the causes that have been considered sufficient for the explanation of the phænomena.

In the first place, I have to notice an erroneous assertion of more than one writer, namely, that I have stated the active Molecules to be animated. This mistake has probably arisen from my having communicated the facts in the same order in which they occurred, accompanied by the views which presented themselves in the different stages of the investigation; and in one case, from my having adopted the language, in referring to the opinion, of another inquirer into the first branch of the subject.

Although I endeavoured strictly to confine myself to the statement of the facts observed, yet in speaking of the active Molecules I have not been able, in all cases, to avoid the introduction of hypothesis; for such is the supposition, that the equally active particles of greater size, and frequently of very different form, are primary compounds of these Mole-

* Communicated by the Author:—Mr. Brown's former paper on this subject, will be found in Phil. Mag. and Annals, N.S. vol. iv. p. 161.

cules,—a supposition which, though professedly conjectural, I regret having so much insisted on, especially as it may seem connected with the opinion of the absolute identity of the Molecules, from whatever source derived.

On this latter subject, the only two points that I endeavoured to ascertain, were their size and figure: and although I was, upon the whole, inclined to think that in these respects the Molecules were similar from whatever substances obtained, yet the evidence then adduced in support of the supposition was far from satisfactory; and I may add, that I am still less satisfied now that such is the fact. But even had the uniformity of the Molecules in those two points been absolutely established, it did not necessarily follow, nor have I any where stated, as has been imputed to me, that they also agreed in all their other properties and functions.

I have remarked, that certain substances, namely, sulphur, resin, and wax, did not yield active particles, which, however, proceeded merely from defective manipulation; for I have since readily obtained them from all these bodies: at the same time I ought to notice that their existence in sulphur was previously mentioned to me by my friend Mr. Lister.

In prosecuting the inquiry subsequent to the publication of my Observations, I have chiefly employed the simple microscope mentioned in the Pamphlet, as having been made for me by Mr. Dollond, and of which the three lenses that I have generally used, are of a 40th, 60th, and 70th of an inch focus.

Many of the observations have been repeated and confirmed with other simple microscopes having lenses of similar powers, and also with the best achromatic compound microscopes, either in my own possession or belonging to my friends.

The result of the inquiry at present essentially agrees with that which may be collected from my printed account, and may be here briefly stated in the following terms: namely,

That extremely minute particles of solid matter, whether obtained from organic or inorganic substances, when suspended in pure water, or in some other aqueous fluids, exhibit motions for which I am unable to account, and which from their irregularity and seeming independence resemble in a remarkable degree the less rapid motions of some of the simplest animalcules of infusions. That the smallest moving particles observed, and which I have termed Active Molecules, appear to be spherical, or nearly so, and to be between 1-20,000dth and 1-30,000dth of an inch in diameter; and that other particles of considerably greater and various size, and either of similar or of very different figure, also present analogous motions in like circumstances.

I have

I have formerly stated my belief that these motions of the particles neither arose from currents in the fluid containing them, nor depended on that intestine motion which may be supposed to accompany its evaporation.

These causes of motion, however, either singly or combined with others,—as, the attractions and repulsions among the particles themselves, their unstable equilibrium in the fluid in which they are suspended, their hygrometrical or capillary action, and in some cases the disengagement of volatile matter, or of minute air bubbles,—have been considered by several writers as sufficiently accounting for the appearances. Some of the alleged causes here stated, with others which I have considered it unnecessary to mention, are not likely to be overlooked or to deceive observers of any experience in microscopical researches: and the insufficiency of the most important of those enumerated, may, I think, be satisfactorily shown by means of a very simple experiment.

This experiment consists in reducing the drop of water containing the particles to microscopic minuteness, and prolonging its existence by immersing it in a transparent fluid of inferior specific gravity, with which it is not miscible, and in which evaporation is extremely slow. If to almond-oil, which is a fluid having these properties, a considerably smaller proportion of water, duly impregnated with particles, be added, and the two fluids shaken or triturated together, drops of water of various sizes, from 1-50th to 1-2000dth of an inch in diameter, will be immediately produced. Of these, the most minute necessarily contain but few particles, and some may be occasionally observed with one particle only. In this manner minute drops, which if exposed to the air would be dissipated in less than a minute, may be retained for more than an hour. But in all the drops thus formed and protected, the motion of the particles takes place with undiminished activity, while the principal causes assigned for that motion, namely, evaporation, and their mutual attraction and repulsion, are either materially reduced or absolutely null.

It may here be remarked, that those currents from centre to circumference, at first hardly perceptible, then more obvious, and at last very rapid, which constantly exist in drops exposed to the air, and disturb or entirely overcome the proper motion of the particles, are wholly prevented in drops of small size immersed in oil,—a fact which, however, is only apparent in those drops that are flattened, in consequence of being nearly or absolutely in contact with the stage of the microscope.

That the motion of the particles is not produced by any cause acting on the surface of the drop, may be proved by an

 inversion

inversion of the experiment; for by mixing a very small proportion of oil with the water containing the particles, microscopic drops of oil of extreme minuteness, some of them not exceeding in size the particles themselves, will be found on the surface of the drop of water, and nearly or altogether at rest; while the particles in the centre or towards the bottom of the drop continue to move with their usual degree of activity.

By means of the contrivance now described for reducing the size and prolonging the existence of the drops containing the particles, which, simple as it is, did not till very lately occur to me, a greater command of the subject is obtained, sufficient perhaps to enable us to ascertain the real cause of the motions in question.

Of the few experiments which I have made since this manner of observing was adopted, some appear to me so curious, that I do not venture to state them until they are verified by frequent and careful repetition.

I shall conclude these supplementary remarks to my former Observations, by noticing the degree in which I consider those observations to have been anticipated.

That molecular was sometimes confounded with animalcular motion by several of the earlier microscopical observers, appears extremely probable from various passages in the writings of Leeuwenhoek, as well as from a very remarkable Paper by Stephen Gray, published in the 19th volume of the Philosophical Transactions.

Needham also, and Buffon, with whom the hypothesis of organic particles originated, seem to have not unfrequently fallen into the same mistake. And I am inclined to believe that Spallanzani, notwithstanding one of his statements respecting them, has under the head of *Animaletti d'ultimo ordine* included the active Molecules as well as true Animalcules.

I may next mention that Gleichen, the discoverer of the motions of the Particles of the Pollen, also observed similar motions in the particles of the ovulum of Zea Mays.

Wrisberg and Muller, who adopted in part Buffon's hypothesis, state the globules, of which they suppose all organic bodies formed, to be capable of motion; and Muller distinguishes these moving organic globules from real Animalcules, with which, he adds, they have been confounded by some very respectable observers.

In 1814 Dr. James Drummond, of Belfast, published in the 7th volume of the Transactions of the Royal Society of Edinburgh, a valuable Paper, entitled "On certain Appearances observed in the Dissection of the Eyes of Fishes."

In this Essay, which I regret I was entirely unacquainted with

with when I printed the account of my Observations, the author gives an account of the very remarkable motions of the spicula which form the silvery part of the choroid coat of the eyes of fishes.

These spicula were examined with a simple microscope, and as opake objects, a strong light being thrown upon the drop of water in which they were suspended. The appearances are minutely described, and very ingenious reasoning employed to show that, to account for the motions, the least improbable conjecture is to suppose the spicula animated.

As these bodies were seen by reflected and not by transmitted light, a very correct idea of their actual motions could hardly be obtained; and with the low magnifying powers necessarily employed with the instrument and in the manner described, the more minute nearly spherical particles or active Molecules which, when higher powers were used, I have always found in abundance along with the spicula, entirely escaped observation.

Dr. Drummond's researches were strictly limited to the spicula of the eyes and scales of fishes; and as he does not appear to have suspected that particles having analogous motions might exist in other organized bodies, and far less in inorganic matter, I consider myself anticipated by this acute observer only to the same extent as by Gleichen, and in a much less degree than by Muller, whose statements have been already alluded to.

All the observers now mentioned have confined themselves to the examination of the particles of organic bodies. In 1819, however, Mr. Bywater, of Liverpool, published an account of Microscopical Observations, in which it is stated that not only organic tissues, but also inorganic substances, consist of what he terms animated or irritable particles.

A second edition of this Essay appeared in 1828, probably altered in some points, but it may be supposed agreeing essentially in its statements with the edition of 1819, which I have never seen, and of the existence of which I was ignorant when I published my pamphlet.

From the edition of 1828, which I have but lately met with, it appears that Mr. Bywater employed a compound microscope of the construction called Culpepper's, that the object was examined in a bright sunshine, and the light from the mirror thrown so obliquely on the stage as to give a blue colour to the infusion.

The first experiment I here subjoin in his own words.

"A small portion of flour must be placed on a slip of glass, and mixed with a drop of water, then instantly applied to the microscope;

microscope; and if stirred and viewed by a bright sun, as already described, it will appear evidently filled with innumerable small linear bodies, writhing and twisting about with extreme activity."

Similar bodies, and equally in motion, were obtained from animal and vegetable tissues, from vegetable mould, from sandstone after being made red hot, from coal, ashes, and other inorganic bodies.

I believe that in thus stating the manner in which Mr. Bywater's experiments were conducted, I have enabled microscopical observers to judge of the extent and kind of optical illusion to which he was liable, and of which he does not seem to have been aware. I have only to add, that it is not here a question of priority; for if his observations are to be depended on, mine must be entirely set aside.

July 28, 1829.

XXV. *On the Atomic Weight of Oxalic Acid and of Mercury. By Mr.* John Prideaux.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN composing a scale of equivalents, now in course of publication,—more extensive, and designed to be more practical, than the one now in use,—I had occasion to examine the atomic weight of mercury, which I fancied Dr. Thomson had doubled; and of oxalic acid in crystals, wherein Dr. Prout having found but three atoms of water, while Dr. Thomson had found four, the latter suggested the probability of more than one variety existing. Being accustomed to meet with two varieties of these crystals, one firm and transparent prisms, the other acicular, friable, and with the aspect of quadroxalate of potash; and happening to possess some of each, I thought they might verify this suggestion.

1st.—18 grains of the friable crystals were dissolved in distilled water, and gradually mixed with a solution of 36 grains of dry transparent crystals of carbonate of soda. The mixture, boiled to drive off the carbonic acid, reddened litmus paper; and required for neutralization 5·15 grains of carbonate of soda. A minute portion more gave signs of alkali.

2nd.—9 grains of the same acid were neutralized with ammonia, and 6·25 grains of carbonate of lime, in clean rhombic crystals, were placed in a test tube with a little distilled water, adding muriatic acid, three drops at a time, until with the aid of heat it was dissolved, when it was washed out into the segment of a Florence flask and slowly evaporated to dryness.

Being

Being redissolved in distilled water, it was poured into the oxalate of ammonia, and thoroughly mixed. When the liquid had become clear, a drop of it in a watch-glass became turbid with muriate of lime. • 0·89 grains of carbonate of lime, treated as above, and gradually added, rendered the liquid insensible to either muriate of lime or oxalic acid. A very small additional portion of muriate made it answer to the latter.

3rd.—$7\frac{7}{8}$ grains of the same acid, treated as above, with $6\frac{1}{4}$ grains carbonate of lime, the liquid was not affected by either the acid or the muriate. A portion of it was poured off, gently evaporated to dryness, and redissolved in a few drops of distilled water. Oxalic acid was added to it, at intervals, till the latter equalled the quantity of salt; but the liquid continued pellucid throughout.

4th.—An ounce of the same acid was re-crystallized, in a solution as dilute as would readily form crystals. They were still acicular, but firm and transparent. 9 grains treated as in Experiment 2, with 6·25 grains of carbonate of lime, required 0·89 grains additional to throw down the acid.

5th.—9 grains of short firm prisms, which I had crystallized three years ago, treated in the same way with 6·25 grains carbonate of lime, disappointed me, by still requiring 0·89 grains carbonate. In both these experiments exact saturation was ascertained by concentration as in Experiment 3, the tests being applied both before and after.

In adopting, therefore, $7\frac{7}{8}$ as the number for oxalic acid in crystals, I do not mean any suspicion on Dr. Thomson's accuracy; but suppose that our Northern brethren of œconomical renown have learned how to clear $12\frac{1}{2}$ per cent on the crystallization.

With respect to mercury, as I do not think the case admits of positive decision, probabilities are all we have to expect. The inertness and dross-like aspect of the black oxide are somewhat indicative of a suboxide; calomel would seem to be a subchloride; and the protonitrate and salts precipitated from it possess the characteristics of subsalts; being very analogous to those of copper, allowing for the difference of affinities and of the consequent tendency to decompose acids and water. Both are so classed by Dr. Wollaston and by Berzelius.

Of the persalts of mercury, it does not appear in any chemical book I possess, that since the establishment of the atomic theory they have undergone any examination on the plan of compound decomposition, so admirably employed by Dr. Thomson. They have been formed by pushing the solution of that metal, by heat, in sulphuric and nitric acids, as far as it

it would go,—a method by which definite proportions were not likely to be attained. It is to be remarked, however, that the nitric and sulphuric solutions thus made are decomposed by water into "sub-" and "bi-" salts: that *red* oxide is produced by the decomposition of sulphuric acid; and that silver and mercury yield analogous compounds by the action of nitric acid and alcohol, in which the former metal is in the state of protoxide, the latter of red oxide. These facts lead to the inference, that red oxide is the oxide of 1 atom of each ingredient; that the "super" sulphate and "super" nitrate are deficient in acid; and the "bi-" salts compounds of one atom acid and one oxide. The property of reddening vegetable blues belongs to the salts of copper and some others, as well as to these.

The following experiments were conducted upon the supposition that 17 represents the atom of corrosive sublimate, consisting of

Mercury............	12·5
Chlorine............	4·5

1st.—The "bi-" sulphate is familiar to chemists, but I was disposed to obtain it by double decomposition. Solutions being made in distilled water of 17 grains corrosive sublimate, and 15⅝ grains crystallized sulphate of copper, were mixed hot and set to crystallize. Solutions also of 17 grains sublimate and 20¼ grains crystallized sulphate of soda were mixed, and gradually evaporated at about 200°. In both the muriate of mercury crystallized out, in the latter contrary to my expectation; and as no other unexceptionable method occurred to me, and the salt was already known, this experiment was abandoned.

2nd.—Solutions of 17 grains corrosive sublimate and 21·5 grains crystallized nitrate of silver were mixed hot and well shaken together; the chloride of silver fell rapidly, and the clear liquor reddened litmus paper. Alternately evaporated and set aside, it refused to crystallize till reduced to dryness.

3rd.—Solutions of 17 grains sublimate and 23⅝ crystallized acetate of lead were mixed warm. Muriate of lead subsided, and the clear liquor smelt stronger of acetic acid, but did not affect test paper much more than the solution of acetate of lead. Two of these mixtures were made: the first (*a*) evaporated at about 200°, and occasionally set aside; the other (*b*) left to spontaneous evaporation in the warm air over the sand-bath. (*a*) when reduced to about a drachm began to deposit nacreous follicules, striated as if fibrous; and the liquid dried away in the course of the night, leaving slender rhombic prisms. (*b*) began to crystallize whilst more than a drachm remained, and was removed to a cold place, where some opaque white crystals

crystals were deposited. Being afterwards reduced on a water-bath, and set aside to dry away, it left prisms like the second crop of (*a*). None of these crystals were deliquescent. Those produced by spontaneous evaporation readily dissolved quite clear in a small quantity of warm distilled water, and gave the characteristic orange-yellow with solution of potash. The prisms and follicules dissolved still more freely in their own weight of cold water; but left a white sediment, which was quickly taken up by a drop of acetic acid. The latter crystals retain their acid with great energy, giving, whether imperfectly dissolved alone, or perfectly by the aid of acetic acid, a *white* precipitate with solution of potash, unless concentrated; in which case the characteristic yellow appears. These acetates remain for further examination.

4th.—Solutions of 17 grains sublimate and 18 dry clear crystals of carbonate of soda were mixed cold, and a similar mixture afterwards made, boiling hot. Dull brick-red precipitates fell, without effervescence, the liquor retaining a slight similar tinge. Poured off and set to evaporate, brick-red crystalline scales continued to form on the surface till reduced to dryness; and a minute portion redissolved with the muriate of soda, from which I did not succeed in completely separating it.

5th.—Solutions of 17 grains sublimate and of $7\frac{7}{8}$ grains crystals of oxalic acid, neutralized with 18 grains carbonate of soda, were mixed warm:—no precipitate ensued. The mixture was evaporated nearly to dryness, during which a white powder subsided. Distilled water being poured on to dissolve the muriate of soda, the solution did not affect litmus paper.

6th.—Similar mixtures were made, containing $9\frac{3}{8}$ grains crystals of tartaric acid and $9\frac{1}{2}$ grains crystals of citric acid, similarly neutralized. No precipitates took place on mixing; nor did they redden litmus paper more than the solution of sublimate. Evaporating and setting by to crystallize, produced little effect on the citric solution; but the muriate of mercury crystallized out of the tartaric. They were then three times evaporated to dryness on a water-bath, adding two drachms of distilled water, to wash away the muriate of soda, after each desiccation: but the precipitates were not sufficiently insoluble to allow of an effectual separation; and the liquid continued to redden litmus paper, particularly the tartaric, where the decomposition was least complete. All the precipitates of Experiments 5 and 6 became orange-coloured in solution of potash. I attempted to produce the oxalate, citrate and tartrate, by combining the acids in atomic proportions, with the red oxide and the precipitated carbonate: but after long digestion

in the cold, repeated desiccation on a gentle sand heat, and some hours boiling, the combination was incomplete in every instance.

Dr. Thomson states (First Principles, vol. ii. p. 404) that pernitrate of mercury, which he had accidentally formed, consisted of

Nitric acid	6·75
Peroxide of mercury......	27·

which he makes one atom of each. But on the affusion of water it was decomposed, peroxide remaining. The same happens with the "super" sulphates and "super" nitrates produced by heat; except that the residual salts are subsulphates and subnitrates. Surely this decomposition indicates a deficiency, not an excess of acid; and it does not take place with the salts produced by double decomposition from corrosive sublimate. The acetate which gave out some acid by heat in evaporation, decomposed in water, like the "super" nitrate, &c. and required a little additional acetic acid to complete the solution. That which crystallized by spontaneous evaporation dissolved perfectly; as do the sulphate, nitrate and muriate, with the same equivalent of acid. In precipitating a metallic bicarbonate in a nearly boiling solution, some effervescence would be expected; yet none occurred in Experiment 4, though part of the carbonate remained dissolved, and was subjected to the heat of a boiling water-bath. It would also be a curious circumstance, if a metallic binoxalate should be so exactly precipitated, that the supernatant liquor would not affect litmus paper, as in Experiment 5, more particularly where, as in that case, evaporation, or heat, was necessary to induce any precipitation at all. The inference follows, that these are not bisalts; nor the others with the same equivalent of acid. The results of the 6th Experiment do not bear upon the question, at least not favourably to my view of it; but it seemed fair to quote them.

There is an objection to the inference above, that if the red be a deutoxide of mercury, it should require two atoms of acid; an objection equally applicable to the salts of copper. But these salts do not manifest the repugnance to crystallization which usually characterizes the salts of such peroxides; and I am not acquainted with any metallic bicarbonate capable of supporting the heat of boiling water. Cinnabar, the most intimate combination of mercury with sulphur, and which therefore (without evidence to the contrary) should be regarded as atom to atom, consists of

Sulphur...	2·
Mercury...	12·5

Thus giving the same number for mercury as inferred above, and

and which upon the whole appears to me the most probable. It nearly corresponds with that of Dr. Wollaston (12·55), and is much more convenient, on the scale, than its double as given by Dr. Thomson.

I am, gentlemen, respectfully, &c.
JOHN PRIDEAUX.

P.S.—I shall, with your permission, send a description of the scale on another occasion: only adding here, that it is double; containing nearly five hundred substances: so disposed as, with a little practice, to be as easy of reference as Dr. Wollaston's, which in dimensions it nearly resembles.

Plymouth, June 12, 1829.

XXVI. *On the Construction and Applications of the improved Sliding-Rod Eudiometer and of the Volumescope. By* ROBERT HARE, *M.D. of Philadelphia.*

[Concluded from p. 122.]

Description of the Volumescope.

IN the following page there is an engraving of an instrument (fig. 5.) which I have advantageously employed, in order to illustrate the experimental basis of the theory of volumes, and some other eudiometric phænomena.

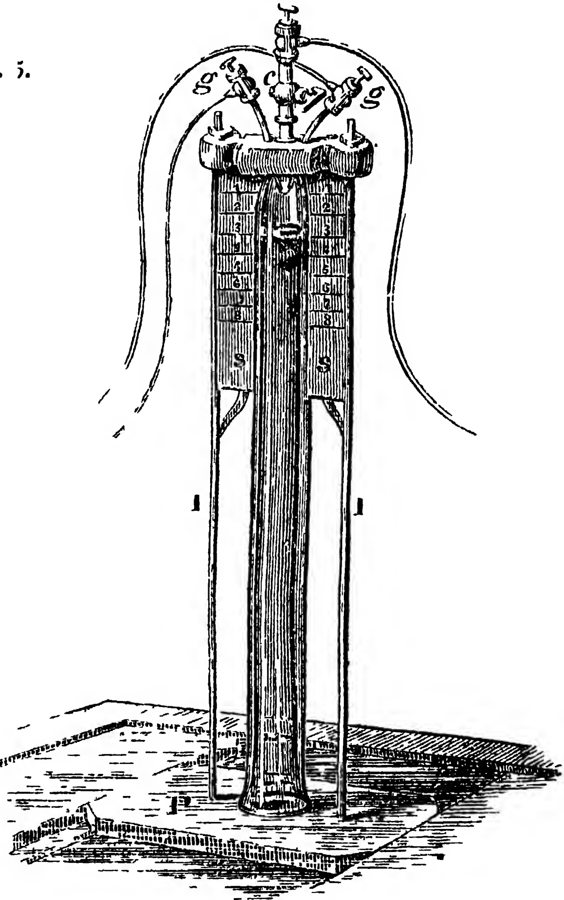
As I find it very inconvenient not to have a name for every variety of apparatus, I shall call this instrument a Volumescope.

It consists of a very stout glass tube, of 36 inches in height, and tapering in diameter inside from $2\frac{1}{8}$ to $1\frac{1}{8}$ inches. The least thickness of the glass is at the lower end, and is there about $\frac{3}{8}$ths of an inch. There is an obvious increase in thickness towards the top within the space of about 6 inches. The tube is situated between the iron rods I I, which are riveted at their lower ends to a circular plate of the same metal let into the lower surface of a square piece of plank. This piece of plank supports the tube so as to be concentric with an aperture corresponding with the bore of the tube, and constituting effectively its lower orifice. The upper orifice of the tube is closed by a stout block of mahogany, which receives a disk of greased leather in a corresponding hollow, formed by means of a lathe, so as to be of the same diameter as the end of the tube. Into a perforation in the centre of the mahogany block communicating with the bore of the tube, a cock C, furnished with a gallows screw, is inserted. Through the block on each side of the perforation, wires are introduced so as to be air-tight. To the upper end of these wires, gallows screws *g g*

 are

are attached. The lower ends of the wires, within the tube, are made to communicate by means of a fine platina wire fastened to them by solder.

Fig. 5.



The apparatus being so far prepared, let it be firmly fixed over the pneumatic cistern, so that the water may rise about an inch above the lower extremity of the tube. To the gallows screws *g g*, attach two leaden rods, severally proceeding from the poles of a calorimotor. By means of a leaden pipe, produce a communication between the bore of the cock and an air-pump, so that by pumping the air from the cavity of the tube, the water of the cistern may be made to rise into the space thus exhausted of air. On each side of the tube, and between it and each iron rod, there is a strip of wood scored

so as to graduate about four inches of the tube into eight equal parts. These parts were measured by introducing into the tube previously filled with water one hundred measures of air, from a sliding-rod gas measure, eight times, and marking the height of the water after each addition*. As each degree thus indicated by the strips will be equal to 100 of those of the sliding-rod, the whole may be considered either as comprising eight hundred measures of the latter, or as eight volumes, each divisible into 100 parts by means of the gas measure.

The apparatus being so far prepared and the tube exhausted of air so as to become full of water, close the cock leading to the air-pump, introduce two volumes of pure hydrogen, and one volume of pure oxygen, which may be most conveniently and accurately effected by the sliding-rod gas measure. The plates of the calorimotor being in the next place excited by the acid, the ignition of the platina wire ensues, and causes the hydrogen and oxygen to explode. When they are pure, the subsequent condensation is so complete, that the water will produce a concussion as it rises forcibly against the leathern disk, which, aided by the mahogany block, has been represented as closing the upper orifice of the tube.

If the preceding experiment be repeated with an excess of either gas, it will be found that a quantity equal to the excess will remain after the explosion. This is very evident when the excess is just equal to one volume, because in that case just one volume will remain uncondensed. By these means, a satisfactory illustration is afforded of the simple and invariable ratio in which the gaseous elements of water unite, when mixed and inflamed; which is a fact of great importance to the atomic theory, and to the theory of volumes.

Application of the Volumescope to the Illustration of the Ratio, in which Nitric Oxide, and the Oxygen in Atmospheric Air, are condensed by admixture.

The tube being filled with water by exhausting it of air, as in the preceding experiment, let five volumes of atmospheric air be introduced into it. Afterwards by means of a volumeter or sliding-rod gas measure, add at once three volumes of nitric oxide. In the next place fill the syphon S Y, (fig. 4.) and the caoutchouc bag attached to it, with water, and pass the leg Y up through the bore of the eudiometer-tube; then by alternate pressure and relaxation, the water may be propelled from the bag, through the syphon into the gaseous mixture, so as to accelerate the absorption.

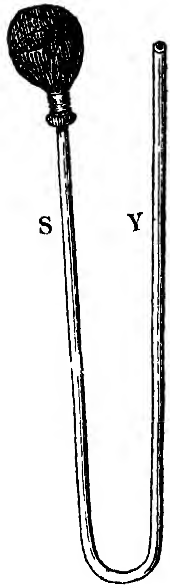
If in five volumes of atmospheric air there be one of oxygen

* See Phil. Mag. and Annals, vol. v. p. 129.

gas,

gas, there will be just enough to condense two volumes of nitric oxide by converting them into nitrous acid. Of course of the eight volumes in the tube, three will disappear and five remain. Hence the gas after the absorption of the red fumes will occupy the same space as the air before the introduction of the nitric oxide. The extent of the deviation, from this result, may be measured by introducing hydrogen by means of the sliding-rod gas measure, until the quantity added causes the gas to extend to the next graduation. By these means it is easy to ascertain how much the residue differs from five or six volumes. I have always found it rather less than five volumes.

Fig. 4.



It is pleasing to observe the perfect coincidence between the results, whether atmospheric air be analysed in the volumescope by explosion with hydrogen, or by its spontaneous reaction with nitric oxide, five volumes of air being in the one case mingled with three of nitric oxide, in the other with a like proportion of hydrogen. I am the more gratified at being enabled to make this statement, as the directions given by such eminent chemists as Dalton, Gay-Lussac, Henry, and Thomson, are discordant.

Gay-Lussac has given a formula, agreeably to which one-fourth of the condensation produced by a mixture of equal parts of atmospheric air and nitric oxide, is to be assumed as the atmospheric oxygen present. As nitric oxide consists of a volume of nitrogen and a volume of oxygen, uncondensed; to convert it into nitrous acid, which consists of a volume of nitrogen and two volumes of oxygen, would require one volume of oxygen: of course if nitrous acid be the product, one-third of the deficit produced would be the quantity of atmospheric oxygen present.' This would be too much to correspond with the formula of Gay-Lussac.

Supposing hypo-nitrous acid produced, only one-half as much oxygen would be required as is necessary to produce nitrous acid; so that instead of two volumes of nitric oxide taking one volume, they would take only a half volume. The ratio of $\frac{1}{2}$ in $2\frac{1}{2}$ is the same as one in five or $\frac{1}{5}$, which is too little for Gay-Lussac's rule.

The formula recommended by Dr. Thomson, agreeably to which, one-third of the deficit is to be ascribed to oxygen gas, is

is perfectly consistent with the theory of volumes, and much more consonant with my experiments, than that recommended by the celebrated author of that admirable theory.

The late Professor Dana ingeniously reconciled Gay-Lussac's statement, with the theory of volumes, by suggesting that one half-volume of oxygen may take one volume of the nitric oxide, and another half-volume of oxygen two volumes.

$\frac{1}{2}$ vol. oxygen takes 1 vol. oxide, and forms nitrous acid.
$\frac{1}{2}$ ———— ——— 2 — oxide, and forms hypo-nitrous acid.
—— —— Deficit due to oxygen gas as 1 to 3. This result is evidently dependent upon the contingencies which may prevent nitrous acid from being the predominant product. I have accordingly found it precarious in at least 100 experiments, accurately made with the sliding-rod eudiometer, of which an engraving and description will be found in the Philosophical Magazine, vol. lxvii. page 29 *.

Application of the Volumescope to the Analysis of Carbonic Oxide, or to that of Olefiant Gas, so as to show that the Result confirms the Theory of Volumes.

Carbonic oxide requiring for its saturation half its bulk of oxygen; in order to analyse it in the apparatus last described, after the preliminary preparations mentioned as necessary, in case of the gaseous elements of water, introduce two volumes of carbonic oxide, and one of oxygen gas, and ignite the platina wire. A feeble explosion will take place, and one volume will disappear. To complete the analysis, by means of a funnel screwed on to the cock inserted into the perforation in the mahogany block at the top of the eudiometer, lime-water may be introduced, and thus all the carbonic acid, generated by the

* I will here mention the mode of operating with that instrument which I find preferable. The receiver being filled with water and immersed in the pneumatic cistern, the apex A being just even with the surface of the water, by drawing out the rod of the eudiometer, take into the tube 100 measures of atmospheric air and transfer them to the receiver. Next take 50 measures of nitric oxide from a bell as above described, and add them to the air in the receiver, without allowing the gas to have any contact with the water, which is not inevitable. Wash the mixture with a jet of water, which is easily produced from the apex of the instrument, and draw the whole of the residual gas into the tube, continuing to draw out the rod till 150 graduations appear. In the next place eject the residual gas from the instrument; the number of graduations of the rod which remain on the outside of the tube shows the deficit produced by the absorption of the oxygen and nitric oxide in the state of nitrous acid. If of this deficit, one-third be ascribed to the atmospheric oxygen, the result will agree very nearly with those obtained by exploding atmospheric air and hydrogen, in the same proportion, in the sliding-rod eudiometer.

the combustion of the carbonic oxide with the oxygen gas, may be absorbed. Of course, if the gases be pure, the absorption will be complete. It might perhaps be found preferable to introduce lime-water by means of the syphon and bag, fig. 4.

Accordance of the Analysis of Olefiant Gas with the Theory of Volumes, illustrated by the Volumescope.

As a volume of olefiant gas consists of two volumes of hydrogen and two volumes of carbon vapour, if it be exploded with an excess of oxygen, say four volumes, all the hydrogen, and one volume of oxygen, will be converted into water. Meanwhile two volumes of oxygen, uniting with two of carbon vapour, will constitute two volumes of carbonic acid. These may be absorbed by lime-water introduced as in the case of carbonic oxide. It follows that one volume of oxygen will remain.

Analysis of a Mixture of Carbonic Oxide, with one or more of the Gaseous Compounds of Carbon and Hydrogen.

If olefiant gas be present, it may be condensed by mingling in any tall narrow vessel protected from light over water, 100 measures of the mixture, with 200 measures of chlorine; and at the end of about a quarter of an hour, agitating the residue with a caustic alkaline solution, to remove any excess of the last-mentioned gas*. The measurement may be easily performed by means of the sliding-rod eudiometer (described in the Phil. Mag. vol. lxvii. p. 29), the residue being transferred into, and measured from the receiver, (fig. 2, same page,) agreeably to the instructions given in the case of nitric oxide, article 148.

The bihydroguret of carbon, usually called carburetted hydrogen†, consists of two volumes of hydrogen and one of carbon condensed into one volume. This gas not being condensible by chlorine, when light is excluded, a mixture of it with carbonic oxide should be analysed by the following process. Being mixed with three times its bulk of oxygen gas within the bell-glass O N, communicating with the receiver of the sliding-rod eudiometer (fig. 1. page 115 of last Number), an adequate quantity may be exploded, pursuant to the directions in the case of carbonic oxide and olefiant gas.

More than half a cubic inch of the gaseous mixture, with the necessary addition of oxygen, cannot be safely exploded at once in any ordinary eudiometer: but by successive operations a large quantity may be exploded, and inferences may be founded upon the accumulated result.

* See *Traité de Chimie*, par Thenard, vol. v. page 34.

† It is sometimes called light carburetted hydrogen.

Let

Let it be imagined that the relative weights of the gaseous mixture in question, of the oxygen gas added to it, and of the carbonic acid produced, have been calculated by multiplying their respective quantities, as ascertained by the eudiometer, by their specific gravities.

Since a mixture of carbonic oxide and bihydroguret of carbon, by combustion with an excess of oxygen, must be wholly converted into water and carbonic acid, and since the carbonic acid is entirely absorbed by lime-water, it follows that the residual gas must be the unconsumed portion of the oxygen gas added to the mixture. Deducting this residual oxygen from the whole quantity of this gas employed, the remainder is the quantity consumed. The weight of the oxygen consumed added to the weight of the gaseous mixture must constitute the whole weight of the products, consisting, according to the premises, of water and carbonic acid only, and deducting the latter, the remainder will be the whole weight of the water generated. Of this, agreeably to the table of equivalents, $\frac{8}{9}$ths must be oxygen, and $\frac{1}{9}$th hydrogen.

And since the ratio of the carbon to the oxygen, in carbonic acid, is as 75 to 200, $\frac{75}{275}$ths or $\frac{3}{11}$ths of the weight of the acid produced will be carbon, and $\frac{200}{275}$ths or $\frac{8}{11}$ths oxygen. If we add, therefore, $\frac{8}{9}$ths of the weight of the water to $\frac{8}{11}$ths of that of the acid, we shall have the weight of all the oxygen in the products. If from the weight thus ascertained, we deduct that of all the oxygen gas consumed, the remainder will be the weight of oxygen in the mixture before the oxygen gas was added. This portion of oxygen is that which entered into the composition of the carbonic oxide, and must, agreeably to the table of equivalents, have been to the carbon in union with it, as 4 to 3. Deducting the weight of the carbon, thus ascertained to exist in the carbonic oxide, from that in the carbonic acid, as above stated, the remainder will be the weight of carbon in the carburetted hydrogen.

The rule may be thus briefly expressed.

From the sum of the weights of the gaseous mixture, and oxygen gas consumed, deduct the carbonic acid generated. To $\frac{8}{9}$ths of the remainder, add $\frac{8}{11}$ths of the weight of the carbonic acid, and deduct the weight of oxygen consumed. The remainder will be the oxygen of the oxide. The carbon in it will be one-fourth less, and this carbon deducted from $\frac{3}{11}$ths of the weight of the carbonic acid will give the weight of the carbon united to the hydrogen*. When

* The problem may be stated algebraically as follows:—

Let M be the weight of the gaseous mixture.

O, of the oxygen gas consumed.

C, of the carbonic acid generated and absorbed.

Then

When there is a copious supply of the gas to be examined, the barometer-gauge eudiometer may be used advantageously; as much larger quantities of gas may be exploded in it than could be exploded in the same time in the sliding-rod eudiometer.

In order to render the process with the barometer-gauge eudiometer safe, the quantity introduced in the first instance should be as small as can be ignited. Afterwards successive portions may be introduced and exploded until the receiver be nearly full of the residual gas. That this operation may be still more secure, I propose to employ, as a receiver, an iron bottle (such as are used to hold mercury) surmounted by a very stout glass tube, in which the platina wire may be situated,

Then $M + O$ will constitute the whole weight of the products.
And $M + O - C$ the whole weight of water.
Also $\frac{8}{9}(M+O-C) =$ all the oxygen in the water.

$\frac{8\,C}{11}$ will be all the oxygen in the carbonic acid.

$\frac{3\,C}{11}$ all the carbon in that acid, and consequently the whole contained in the products.

$\frac{8}{9}(M+O-C) + \frac{8\,C}{11}$ will be all the oxygen in the products.

And $\frac{8}{9}(M+O-C) + \frac{8\,C}{11} - O$ will be that portion of oxygen which existed previously in the gas, which call X.

We have therefore the following equation,

$$X = \frac{8\,M + 8\,O - 8\,C}{9} + \frac{8\,C}{11} - O. \text{ Which may be thus reduced.}$$

$$X = \frac{88\,M + 88\,O - 88\,C + 72\,C}{99} - O.$$

$$X = \frac{88\,M + 88\,O - 16\,C}{99} - O.$$

$$X = \frac{88\,M + 88\,O - 16\,C - 99\,O}{99}$$

$$X = \frac{88\,M - 16\,C - 11\,O}{99}$$

It follows from the atomic weights, and the premises, that

$\frac{3\,X}{4} =$ the carbon in carbonic oxide. And $X + \frac{3\,X}{4} =$ weight of carbonic oxide.

Also $\frac{3\,C}{11} - \frac{3\,X}{4} =$ the carbon united to hydrogen.

And $\frac{3\,C}{11} - \frac{3\,X}{4} + \frac{M+O-C}{9} =$ weight of carburetted hydrogen.

tuated, which is to cause ignition. This tube would be the only part of the apparatus which it would be desirable to have transparent. Indeed transparency may be dispensed with altogether, the explosion being perceptible from the noise, and the effect upon the gauge.

Analysis of a Gaseous Mixture in which Bihydroguret of Carbon, Carbonic Oxide, and either Hydrogen or Azote, or both the latter, are intermingled.

When, as in the case under consideration in the preceding article, there is no azote present, the gas which remains after the action of the lime-water may be considered as oxygen; but if azote be present, the residual gas must be analysed in order to ascertain the quantity of oxygen which remains unconsumed.

This is easily accomplished by propelling the residual gas into the receptacle for carbonic acid R, fig. 1, and substituting a self-regulating reservoir of hydrogen for the bell-glass. Then having filled the gauge and pipes with the pure hydrogen, by the manipulation already described in the case of oxygen, the residual gas may be drawn into the receiver, exploded, and the resulting deficit ascertained; to one-third of which the oxygen is equivalent.

Instead of resorting to the method just mentioned, the residual gas, after being included in the receptacle, may be transferred to the pneumatic cistern, and analysed by the aqueous sliding-rod eudiometer.

If we subtract from the weight of the "*residual gas*," the weight of the oxygen found in it, the remainder being both incombustible and insusceptible of absorption by lime-water, should be considered as the weight of the azote. This would have to be deducted from that of the gaseous mixture, the calculation being otherwise unaltered.

If after having analysed a gaseous mixture, agreeably to the directions given in the last article, it be found that the quantity of hydrogen indicated exceed in weight, one-third of the carbon allotted to it, the excess must be considered as pure hydrogen; since, agreeably to the table of equivalents, the weight of the carbon in the bihydroguret is to the hydrogen as 3 to 1 *.

* That is, putting H for the pure hydrogen, we should have

$$H = \frac{M + O - C}{9} - \frac{1}{3}\left(\frac{3C}{11} - \frac{3X}{4}\right)$$

Method of ascertaining the Proportions of Bihydroguret of Carbon and Carbonic Oxide in a Mixture of those Gases, provided no other inflammable Gas be present. By FRANKLIN BACHE, *M.D., &c. &c. &c.*

I will here subjoin an excellent method of ascertaining the proportions of bihydroguret of carbon and carbonic oxide, in a mixture of those gases, which has been ingeniously and correctly suggested by my friend Dr. Bache.

"The proportion of carbonic oxide in a mixture of this gas and bihydroguret of carbon, may be calculated from the quantity of oxygen consumed by them when exploded, in the following manner.

"If we suppose a gas to be all bihydroguret of carbon, it will consume twice its volume of oxygen: if, on the other hand, it be all carbonic oxide, it will require half its volume for complete combustion. It must be evident, therefore, that a mixture of these gases will consume a volume of oxygen, intermediate between half the volume and twice the volume of the mixture; and that whatever may be the volume of the oxygen consumed, it will bear a constant proportion to the carbonic oxide present.

"Reasoning from the analysis of the pure bihydroguret, which requires twice its volume for complete combustion, it must be apparent that the introduction of the least portion of carbonic oxide will necessarily diminish the quantity of the oxygen consumed. Now it will be found that this diminution of the quantity of the oxygen required, bears to the carbonic oxide present the constant ratio of 3 to 2. Hence we have this proportion:—

"As 3 is to 2,

So is the deficit of oxygen above alluded to, to the carbonic oxide present.

"This mode of calculating the carbonic oxide in the mixture supposed, may be expressed in an algebraic formula, as follows:—

"Let M = volume of the gaseous mixture, and

O = volume of oxygen consumed.

Then $\frac{2\,M - O \times 2}{3}$ = volume of carbonic oxide present.

And as carbonic oxide contains half its volume of oxygen, then

$\frac{2\,M - O}{3}$ = volume of oxygen in the carbonic oxide."

This method is evidently preferable in the case of a mixture known to consist of pure bihydroguret and carbonic oxide: but unfortunately it is inapplicable if hydrogen be present in

any

any other state than as a definite compound with carbon, requiring twice its volume of oxygen for saturation. The process of Dr. Bache is not competent to inform us what the gases are; but enables us, when their nature is known, to discover their proportions.

XXVII. *On* Hadley's *Sextant*.

(*From* Prof. Encke's *Ephemeris for* 1830, *p.* 285.)

[Continued from p. 92.]

IN thus using the sextant as a heliotrope, the angle between the sun and the object must not much exceed 90°; but this defect may be easily remedied by using a large mirror for reflecting the image of the sun. It will perhaps be useful to mention in this place a circumstance which at first sight may appear strange. If we measure the angles between objects in which parallel lines are visible, and whose angular distance is not very small, these parallel lines will intersect each other at very sensible angles while bringing the images to coincidence whenever the plane of the sextant must be considerably inclined to these lines. The doubly reflected image retains the same inclination towards the plane of the sextant taken in the same sense, after the double reflexion; but for this very reason the lines lose their parallelism. Let us designate, for brevity, the plane which the parallel lines intersect at right angles, by the name of horizon (from the case which most frequently occurs), and let us call the elevations of the objects above the horizon h and h', and next form the triangle between the zenith and the two objects. In this triangle, let the angle at the zenith = A, the interior angle at the direct image = C, and the exterior angle at the doubly reflected image = B; and the angle at which the vertical images will intersect each other will be = B − C. By Napier's analogies, or Gauss's formulæ, we obtain

$$\mathrm{tang}\,\tfrac{1}{2}\,(B-C) = \frac{\sin\frac{1}{2}\,(h'+h)}{\cos\frac{1}{2}\,(h'-h)}\,\mathrm{tang}\,\tfrac{1}{2}\,A$$ and introducing the measured angle s

$$\mathrm{tang}\,\tfrac{1}{2}(B-C) = \mathrm{tang}\,\tfrac{1}{2}s\,.\,\mathrm{tang}\,\tfrac{1}{2}(h'+h)\sqrt{\left(\frac{1-\mathrm{tang}\,\frac{1}{2}\,(h'-h)^2\,\mathrm{cotg}^2\,\frac{1}{2}s}{1-\mathrm{tang}\,\frac{1}{2}\,(h'+h)^2\,\mathrm{tg}^2\,\frac{1}{2}s}\right)}$$

The quantity under the radical sign will seldom much differ from 1, so that the first two factors will be sufficient.

Whoever possesses the proper astronomical apparatus will have no difficulty in determining the constants here required. Let it suffice here to suggest a method which requires only such simple apparatus as every body may easily procure.

An instrument for determining the position of the plane of the sextant is indispensably requisite. For the use of the

sextant

sextant it is only necessary to know it to the nearest minute, which may be easily attained by a common level, or some other method. In fact, the equally high sight vanes, or the trial telescope which has been proposed for this purpose, come under the description of levels. Besides the level, all that is absolutely required will be a detached telescope furnished with cross wires, whose magnifying power need not be greater than that of the telescope of the sextant, but which ought to have a large aperture; a sweeper will best answer this purpose. The telescopes of sextants have commonly two wires, between which the contact is to be observed. For a more accurate determination of the line of collimation, cross wires are besides placed nearly in the middle between the two former wires. One may at first ascertain the distance of each wire from the intersection of the cross wires. For this purpose they are to be placed, as nearly as the eye can judge, perpendicular to the plane of the sextant; then the direct image of a clear and distinct terrestrial object is to be placed in the intersection of the cross wires, while the image of the same object by double reflexion is bisected by one of the lateral wires. Let the angle read off after this operation be called s, which is to be taken as negative if it is on the arc of excess. The two images are next made to change places, so that the direct image is now on the lateral wire, and the doubly reflected one on the intersection of the cross wires, and let the angle then be $= s'$. It will appear from fig. 1. (See above, p. 85.) that under these circumstances, calling the distance of the lateral wire m (positive if to the right of the cross wire), we have

$$s - c_0 = m - \frac{f}{d} \sin 2\beta \text{ and } s' - c_0 = -m - \frac{f}{d} \sin 2(\beta - m)$$

whence $$m = \tfrac{1}{2}(s - s') + \frac{f}{d} \sin m \,.\, \cos(2\beta - m)$$

$$c_0 = \tfrac{1}{2}(s + s') + \frac{f}{d} \cos m \,.\, \sin(2\beta - m)$$

The sign of m will without any uncertainty decide the position of the lateral wire, if, agreeably to the rule constantly to be observed, we consider as negative such s's as fall on the arc of excess. These determinations serve for having in the field of vision an estimate of the errors still remaining.

Let the wires now be placed parallel to the plane of the sextant, and let this plane be put into an exactly horizontal position while the telescope points to a clear terrestrial object having some distinct points on it. It will now be convenient to take away the small mirror which is in the way of seeing the object, as also the coloured screens, if they should be found to interfere with this operation.

The

The detached telescope is now to be placed behind the sextant, so that its line of collimation is as nearly as possible in the same level with that of the telescope of the sextant, and is to be directed to the same point. If the telescope has a large aperture, the intermediate position of the sextant will not be any great obstacle to distinct sight. The sextant is now turned 180°, and its plane is again brought into a horizontal position; if we now look into the detached telescope, the coincidence of the two points of intersection of the cross wires of both telescopes will prove that there is no error of inclination; if they do not coincide, the distance of the two points will be $= 2\,i$. It will not be difficult to take one half of this distance, because, on the above supposition, we see through the detached telescope, at the same time, the point previously determined, and the cross wires of the telescope of the sextant. If the telescope is therefore directed to the point of bisection of this distance, and if the position of the telescope of the sextant is then so corrected as to cover the intersection of the wires in their new position, we shall have at least nearly $i = 0$, as will be seen by repeating the operation by way of verification. The ring into which the telescope of the sextant is screwed, is commonly furnished with means of correction by turning about two points; otherwise the place in the field of vision is to be marked by a new cross wire; or, if the distance is small, taken by estimation from its relative position to the lateral wires.

In some trials in this observatory with a sextant made by Troughton, in which at first very rough methods were applied, and afterwards in applying more accurate ones the terrestrial object was replaced by the cross wires of an altitude circle, a difference of $30''$ was found, the cause of which was entirely to be attributed to the deficient methods of levelling first used. With common care it will, however, be easy to ascertain i as accurately as the power of the telescope of the sextant will admit. By means of the sextant's telescope thus adjusted, let the line of collimation of the detached telescope in a lateral position be made horizontal, the sextant being placed horizontally, and the position of the detached telescope being changed until its cross wires cover that place of the field of the sextant's telescope, for which $i = 0$. The angle which the line of collimation in this new position makes with the former object, may be measured by the sextant; let it $= p$. If the sextant is now turned in the same horizontal plane until the image of the former object in the same horizontal plane, once reflected by the large mirror, is seen in the telescope, this will furnish the means of determining l. If the cross wires cover the object exactly in the various positions of the large mirror,

mirror, l will $= 0$. If this be not possible, observe the objects to which the telescope points, with the sextant's telescope, and the known distance of the lateral wires will afford means of estimation sufficiently accurate for the present purpose. If the angular distance of this point (positive if north) from the one formerly determined be $= q$, we obtain by the solution of the right-angled triangle whose hypothenuse is bisected,

$$\sin l = \frac{\sin q}{2 \cos \frac{1}{2} p \,.\, \sqrt{(\cos \frac{1}{2} q^2 + \sin \frac{1}{2} q^2 \operatorname{tang} \frac{1}{2} p^2)}}$$

for which we may always put

$$l = \tfrac{1}{2} q \,.\, \sec \tfrac{1}{2} p.$$

Accordingly as the index has been placed on 0°, 60°, 120°, or other angles, l_c, l_1, l_2 will be found; and hence it will be seen whether it is necessary to introduce the quantities δ, γ, u. For any good sextant this will hardly ever be necessary.

For the sextant above referred to, it was found that

$$\begin{array}{llll} p \text{ being } 89^\circ\, 25' \text{ and } s = & 0^\circ, & q \text{ was } = & +\, 11'\, 20'' \\ & = 60 & = & +\, 11\;\; 20 \\ & = 120 & = & +\, 12\;\;\; 0 \end{array}$$

whence
$$\begin{aligned} l_0 &= 7'\, 58'' \\ l_1 &= 7\;\; 58 \\ l_2 &= 8\;\; 27 \end{aligned}$$

These differences cannot be ascribed to the instrument. They arise partly from the inequality of the different operations of levelling, partly from the impossibility of obtaining a firm position for the detached telescope on the unsteady floor of our observatory: at any rate, their influence is entirely evanescent. The small mirror is now to be replaced, and the sextant, in a firm position, directed to an object the images of which are made to coincide on the intersection of the wires by means of the adjusting screws of the small mirror. By this process the small mirror is made parallel to the large one, and the reading off will give c_1. Next let us look with the detached telescope into the large mirror, and let the intersection of the wires be directed to the image of the same object once reflected. If we then measure with the sextant the angle between this intersection and the object, we shall have

$$s - c_0 = 2\beta - \frac{f}{d} \sin 2\beta, \quad \text{but as}$$

$$c_0 = c + \frac{f}{d} \sin 2\beta, \quad \text{we have}$$

$$2\beta = s - c_1$$

In Troughton's sextant 2β was found $= 33^\circ\, 46'\, 40''$; in one made by Ramsden, in the observatory of Seeberg, $= 31^\circ\, 30'$; in the one by Cary, in the observatory at Göttingen, according to Bohnenberger, $= 30^\circ$. In general it will not differ much from

from 30°, as on the one hand its magnitude determines that of the greatest angle which it is possible to measure, and on the other is limited again by the dimensions and the distance of the two mirrors. The small correction of β arising from the inclination of the large mirror is entirely to be neglected.

By means of this operation we obtain likewise the index-error of the instrument. It seems that it is erroneously supposed, that this error cannot be as accurately determined by terrestrial objects as by the sun. In most cases it is easy to obtain with sufficient accuracy the data requisite for the small correction, which is to be applied in the former case. If the object is projected on the sky, we have the advantage of a perfectly quiet observation, while the sextant is firmly at rest, and the contact of the images may be made with greater accuracy than the sextant can be read off. We have at the same time a means of determining the errors of the coloured glasses by comparing the index-error thus determined with that obtained by each coloured glass. The correction is the same for all angles, as the path of the rays through the coloured glasses is under all circumstances the same.

There is another method of determining the angle β with the sextant only, by a process with which Prof. Gauss made me acquainted when showing me the use of the sextant for heliotropical purposes. If the great mirror is turned back as far as is requisite for nearly the greatest angle which the sextant is capable of measuring, an image will be obtained, after a single reflexion from the small mirror of such luminous objects as send their rays closely past the frame of the large mirror directly to the small mirror. These images will only be visible on the left side of the field of view, as the light to the middle of it is intercepted by the large mirror. It will be advantageous to cover the back of the small mirror by the coloured glasses or otherwise, in order to prevent the direct rays from rendering invisible the images produced by single and double reflexion.

In order to compare the paths of these two rays, let us suppose that the sextant is placed in the plane of the objects whose images are thus seen by single and double reflexion. The line of vision we suppose to be fixed; let its direction be A, (fig. 1. p. 85.) If we now suppose that the image seen by one reflexion is observed on one of the lateral wires whose positive distance, according to the above-stated assumption in determining the distances of the wires, is $= m$; and if we count the angles from p to A, the first path of the once reflected ray from the eye will be in the direction $\beta - m$, and after the reflexion its direction from O is through the point $180° - (\beta - m)$, in

which direction the object (neglecting the parallax) is situated. If at the same time the doubly reflected image of another object is observed on the lateral wire whose distance is m', this object lies with regard to O in the direction $2\alpha + \beta - m'$; and if in this position of the sextant the reading is $= s$, we have

$$s - c_0 = 2\alpha;$$

the difference of these two directions is the real angular distance of the two objects. If this distance is now actually measured with the sextant, the reading of which must then be $= s'$, we shall have this equation:

$$s' - c_0 = 180° - (\beta - m) - (s - c_0 + \beta - m') \text{ whence}$$
$$2\beta = 180° - (s + s' - m - m' - 2c_0).$$

In this case m must always be negative. Should the construction of the sextant and the brightness of the images permit their being brought into contact on the same wire, which likewise depends on the number of objects from which a selection is to be made, we shall have, calling the absolute distance of the wire m, $2\beta = 180° - (s + s' + 2m - 2c_0)$..

The process is therefore as follows: Near the left side of the field of vision a wire is to be fixed, the absolute distance of which, m, is to be determined as shown above. On this, if possible, two objects are brought into contact after single and double reflexion, as near as possible to the horizontal wire of the cross wires, and the sextant read off; let the reading be s. Then the real angle of the objects is to be measured, and if the reading of the sextant in this measurement is $= s'$, and c_0 the index-error, we shall have the angle β by the preceding formula. It is clear that all adjustments of the sextant are here supposed to have been made. The former of these operations cannot well be performed without a stand.

In Troughton's sextant the distances of the two lateral wires from the middle one were nearly equal, each 33'. With $l = +8'$, which is a sufficiently accurate mean value, we obtain,

s	i'	$-2l^2 \tan \frac{1}{4}s$	s	i'	$-2l^2 \tan \frac{1}{4}s$
0	+7' 39"	0"·0	70	+8' 23"	−0"·7
10	7 45	−0 ·1	80	8 30	−0 ·8
20	7 51	−0 ·2	90	8 37	−0 ·9
30	7 58	−0 ·3	100	8 44	−1 ·0
40	8 4	−0 ·4	110	8 52	−1 ·2
50	8 10	−0 ·5	120	9 0	−1 ·3
60	8 17	−0 ·6	130	9 8	−1 ·4

To the lower lateral wire corresponds $i = +33'$, to the upper one

one $i = -33'$. If i had not been made $= 0$ but equal to the mean value of i', the deviation would be equal on both sides, and this would perhaps be most convenient for the observation. If we designate however, in the present case, the place of the image, if on the lower wire, by L, if in the middle between the lower and central cross wire, by $\frac{1}{2}$ L, and if in the same manner $\frac{1}{2}$ U, and U denote similar positions with regard to the upper wire, as also C with regard to the central cross wire,—we may calculate the following table for the sextant of this observatory.

	Δ *s*				
	L	½ L	C	½ U	U
0°	− 0″·0	−0″·0	−0″·0	− 0″·0	− 0″·0
10	− 1 ·1	−0 ·2	−0 ·2	− 1 ·1	− 2 ·6
20	− 2 ·1	−0 ·4	−0 ·4	− 2 ·0	− 5 ·3
30	− 3 ·2	−0 ·6	−0 ·6	− 3 ·1	− 8 ·1
40	− 4 ·3	−0 ·9	−0 ·8	− 4 ·2	−11 ·1
50	− 5 ·5	−1 0	−1 ·0	− 5 ·5	−14 ·3
60	− 6 ·8	−1 ·3	−1 ·3	− 6 ·8	−17 ·8
70	− 8 ·1	−1 ·5	−1 ·6	− 8 ·3	−21 ·6
80	− 9 ·6	−1 ·7	−1 ·9	−10 ·0	−26 ·0
90	−11 ·3	−2 ·0	−2 ·2	−11 ·9	−31 ·1
100	−13 ·2	−2 ·3	−2 ·6	−14 ·2	−37 ·2
110	−15 ·7	−2 ·7	−3 ·2	−17 ·2	−44 ·9
120	−18 ·7	−3 ·0	−3 ·8	−21 ·0	−54 ·6
130	−22 ·7	−3 ·4	−4 ·5	−26 ·0	−67 ·9

If the ring of the telescope be sufficiently steady, this table of errors will be applicable for a long period, because l may be considered as perfectly invariable, provided means are taken to insure the parallel position of the mirrors. It is apparent from this table how far from the middle the contact of the images may be observed without committing considerable errors; and it is likewise clear that it is hardly to be expected that any number of observations with a sextant, however great, will give a large angle within three or four seconds; partly on account of the inferior power of the telescopes of the sextant, and partly because all errors of observation with sextants without a stand have always the same sign. It really appears, that when this instrument first became known in Germany, its powers were overrated.

XXVIII. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones.* By J. G. CHILDREN, *F.R.S. L. & E. F.L.S. &c.*

[Continued from page 107.]

Genus 66. CARADRINA, *Ochs.*, *Treitsch.* (Steph.)*

Legs rather short, not very stout: *femora* with moderate fascicles of hair.

Wings slightly deflexed, entire, very glossy; *anterior* with strigæ and distinct stigmata.

Palpi rather short, somewhat porrect, a little ascending, squamose, the terminal joint exposed at the apex; triarticulate, slender, basal joint reniform, about one-third the length of the second, which is very long, slightly bent, and a little narrowed towards the apex; terminal minute, ovate-obtuse: *maxillæ* not longer than the antennæ.

Antennæ slender, more or less ciliated in both sexes.

Head small, densely squamose: *eyes* small, naked: *thorax* moderately stout, obsoletely crested.

Larva naked.

Pupa subterranean †.

This genus is divided into four families, by Treitschke, according to the markings on the wings.

FAM. A. Species.	Icon.
1. Car. *Glareosa*, Esp. ...	Ernst, VII. Pl. CCLIV. f. 416.

* In his 29th Number, which had not appeared when our last went to press, Mr. Stephens has adopted Ochsenheimer's genus Calyptra, (Calpe, *Treitsch.*) with the following characters:

"*Palpi* elongate, ascending clothed with short capitate scales, which are rather longest in front of the two basal joints; the terminal joint scarcely less robust than the preceding; the basal joint shorter than the apical, rather stouter than the second, which is twice the length of the first, and a little acuminated at the apex, terminal joint nearly as long as the second, linear, its apex a little turned: *maxillæ* rather short. *Antennæ* rather short, robust, bipectinated to the apex in the males, the pectinations very short at the tip, subserrated and pubescent in the females: *head* transverse, with a tuft of scales on the forehead: *eyes* rather small, globose, naked; *thorax* stout, with a short acute crest anteriorly; *abdomen* rather stout, somewhat depressed, obtuse at the apex, the male with a subquadrate tuft: *wings* deflexed during repose; *anterior* deeply emarginate, and dentate on the hinder margin; *posterior* slightly denticulate: *legs* stout, woolly; two basal joints of the *posterior tarsi* with long fascicles of scales, especially in the male. *Caterpillar* slender, naked: *pupa* folliculate."—*Steph. Illust. Brit. Ent. Haust.* III. 49.

Only one British species *No. libatrix*, Linn.

† Characters from Stephens. *Haust.* II. p. 154.

2. Car.

Species.	Icon.
2. Car. *Morpheus*, Götze. .	Ernst, VII. Pl. CCLX. f. 406. e.
3. — *Cubicularis*, Hübn.	Ernst, VII. Pl. CCLX. f. 403. a.
4. — *Exigua*, Hübn....	Hübn. Noct. Tab. 78. f. 362. (fœm.)
FAM. B.	
5. Car. *Palustris*, Hübn.	Hübn. Noct. Tab. 79. f. 367. (mas.)
6. — *Lenta*, Treitsch.*	
7. — *Stagnicola*, Treitsch.†	
FAM. C.	
8. Car. *Superstes*, Ochs.	Ernst, VII. Pl. CCLX. f. 406. a.
9. — *Ambigua*, Fab......	Hübn. Noct. Tab. 125. f. 576. (mas.)
10. — *Blanda*, Fab.......	Hübn. Noct. Tab. 125. f. 575. (mas.)
11. — *Alsines*, Hübn. ...	Ernst, VII. Pl. CCLX. f. 406. b—d.
12. — *Respersa*, Hübn...	Hübn. Noct. Tab. 34. f. 164. (fœm.)
13. — *Iners*, Treitsch‡.	
FAM. D.	
14. Car. *Trilinea*, Hübn.§	Ernst, VI. Pl. CCXXXVI. f. 344. a—c.
15. — *Bilinea*, Hübn.§	Hübn. Noct. Tab. 45. f. 217. (mas.)
16. — *Virens*, Linn.......	Ernst, VII. Pl. CCXCIII. f. 495.

Genus 67. SIMYRA, *Ochs.*, *Treitsch.*

Wings deflexed; marked with bright streaks and interspersed dark spots, without any transverse bandings.

* Car. alis anticis cinereo nitidis, strigis ordinariis fasciâque mediâ nigricantibus, maculâ orbiculari minimâ, atrâ; posticis plumbeis. — *Ochs. Treitsch.* V. *pars* II. p. 257.

† Car. alis anticis cæruleo plumbeis, maculis duabus dilutioribus, orbiculari solito majore, obliquâ; posticis albidis fusco adspersis. — *Ochs. Treitsch. l. c. p.* 258.

‡ Car. alis anticis flavo albicantibus, atomis griseis adspersis, serie punctorum nigrorum unicâ; posticis maris albis.—*Ochs. Treitsch.* V. *pars* II. p. 271.

§ GRAMMESIA [a], Stephens.

"*Palpi* short, scarcely ascending; densely squamous, the terminal joint with its apex only exposed; triarticulate, not very slender, the basal joint above half the length of the second, reniform, contracted at the base; the second subcylindric; terminal, elongate-ovate, somewhat acuminated at the apex, about one-third as long as the second: *maxillæ* as long as the antennæ. *Antennæ* rather long, serrated in the males, simple in the females: *head* and *eyes* small, the latter naked: *thorax* stout, woolly: *wings* slightly deflexed: *anterior* with transverse lines, stigmata obscure, or wanting; entire, rounded behind, the apex obtuse: *legs* rather short, stout; *femora* with dense fascicles of hair. *Larva* naked: *pupa* subterranean."—*Steph. Illust. Brit. Ent. Haust.* II. p. 151.

[a] Γραμμη *linea.*

Antennæ

Antennæ bipectinate in the male.
Body, with the back thickly covered with dense scales.
Larva hairy; *pupa* inclosed in a white, compact web.

Species.	Icon.
1. Sim. *Venosa*, Borkh....	Hübn. Noct. Tab. 81. f. 380. (fœm.)
2. — *Nervosa*, Fab......	Ernst, VI. Pl. CCXLVII. f. 367.
3. — *Musculosa*, Hübn.	Ernst, VI. Pl. CCXXXVII. f. 346.
4. — *Punctosa*, Treitsch.*	

Genus 68. LEUCANIA, *Ochs.*, *Treitsch.* (Stephens, Curtis.)

HELIOPHILÆ, Hübner.

Wings incumbent during repose; *anterior* rather narrow, the hinder margin entire†, the apex acute; *nervures* distinct, apparently elevated.

Antennæ simple in both sexes, thickly ciliated beneath, especially in the males.

Palpi rather short, considerably bent upwards, approximating, the basal joints with elongate compact scales, the terminal exposed and nearly denuded, obtuse; basal joint slightly bent, horizontal, second vertical, as long again as the first, slightly bent at the base, and a little attenuated at the apex; terminal slender, elongate-ovate: *maxillæ* moderate.

Head small, subtrigonate: *eyes* globose, large, pubescent, rarely naked.

Thorax rather stout, woolly, not crested.

Abdomen slightly elongate, carinated, rather slender in the males, with a large tuft at the apex, stouter, and somewhat conic in the females.

Larva slightly pilose: *pupa* folliculated‡.

Species.	Icon.
1. Leuc. *Pallens*, Linn. ...	Ernst, VII. Pl. CCXCVIII. f. 505. f. g.
2. — *Elymi*, Treitsch.§	— — —
3. — *Impura*, Hübn...	Hubn. Noct. Tab. 85. f. 396. (mas.)

* Sim. alis anticis albido fuscis, lineâ bascos nigrâ, striâ longitudinali cinereâ, puncto medio albo; posticis albis.—*Ochs. Treitsch.* V. *pars* II. 287.

† A distinguishing character, according to Stephens, between Leucania and Nonagria.

‡ Characters from Stephens.—*Haust.* iII. p. 73.

§ Leuc. alis anticis solito longioribus, pallidè flavis, atomis fuscis adspersis, serie externâ striolarum, fuscarum.—*Ochs. Treitsch.* V. *pars* II. p. 294.

4. Leuc.

Species.	Icon.
4. Leuc. *Straminea*, Treits.*	— — —
5. — *Pudorina*, Hübn.	Ernst, VII. Pl. CCXCVIII. f. 505. a—c.
6. — *Obsoleta*, Hübn...	Ernst, VII. Pl. CCXCVII. f. 503. c.
7. — *Comma*, Linn.....	Ernst, VII. Pl. CCXCVII. f. 504.
8. — *L album*, Linn. †	Ernst, VII. Pl. CCXCVII. f. 503. a. b. d.

Genus 69. NONAGRIA, *Ochs.*, *Treitsch.* (Stephens.)

Wings deflexed during repose: *anterior* elongate, narrow, slightly crenated on the hinder margin; posterior somewhat triangular, faintly denticulate.

Antennæ rather short, stout, subserrated, sometimes slightly pectinated in the males, pubescent beneath.

Palpi nearly vertical, very thickly clothed with elongate scales on the two basal joints, the terminal one exposed, with the scales rather elongated beneath; basal joint reniform, nearly horizontal, stouter than the following, and above half its length; the second rather elongate, straight, acuminate; the terminal very short; ovate: *maxillæ* moderate.

Head small, subtriangular, with a dense tuft of scales on the forehead: *eyes* large, globose, naked.

Thorax rather stout, slightly crested anteriorly.

Abdomen elongated, not very robust, with a large tuft at the apex, especially in the males ‡.

Larva fleshy, lives within the stems of reeds and other plants, and feeds on their internal substance: *pupa* internal.

Species.	Icon.
1. Non. *Ulvæ*, Hübn......	Hübn. Noct. Tab. 139. f. 635. (mas.) f. 636. (fœm.)
2. — *Despecta*, Treitsch. §	— — —
3. — *Fluxa*, Hübn. ‖ ...	Hübn. Noct. Tab. 88. f. 413. (fœm.)
4. — *Extrema*, Hübn...	Hübn. Noct. Tab. 88. f. 412. (fœm.)
5. — *Phragmitidis*, Hübn.	Hübn. Noct. Tab. 47. f. 230, (on the plate 330) (mas.)

* Leuc. alis anticis pallidè stramineis, punctis tribus medio, pluribus ad marginem in seriem dispositis, nigris; posticis albis fusco venosis.—*Ochs. Treitsch. l. c.* p. 297.

† Add, Leuc. *Littoralis*, (The Sea-shore Wainscot.) *Curtis, Brit. Ent.* vol. iv. Pl. 157.

‡ Characters from Stephens. *Haust.* III. p. 71.

§ Non. alis anticis micantibus fusco ferrugineis, margine anteriore dilutiore, fimbriis obscurioribus.—*Ochs. Treitsch.* vol. v. *pars* II. p. 311.

‖ Leucania, Steph.

6. Non.

Species.	Icon.
6. Non. *Neurica*, Hübn.*	Hübn. Noct. Tab. 82. f. 381. (mas.) —Tab. 144. f. 659 et 660. (mas.) f. 661. (fœm.)
7. — *Paludicola*, Hübn.	Hübn. Noct. Tab. 136. f. 624. (fœm.) —Tab. 137. f. 628. (mas.) f. 629. (fœm.) Tab. 139. f. 637. (mas.)
8. — *Sparganii*, Hübn.	Hübn. Noct. Tab. 118. f. 549. (mas.) f. 550. (fœm.)
9. — *Cannæ*, Treitsch.	Ernst, VII. Pl. CCXCVI. f. 501.
10. — *Typhæ*, Hubn. ...	Ernst, VII. Pl. CCXCVI. f. 502.

Genus 70. GORTYNA, *Ochs.*, *Treitsch.* (Stephens, Curtis.)

Wings deflexed when at rest; *anterior* triangular, slightly emarginate at the apex; cilia of all a little indented.

Antennæ simple in both sexes, clothed with scales above, pubescent beneath.

Palpi short, slightly ascending, the basal joints clothed with long hair-like scales, the terminal exposed, ovate obtuse; the basal joint curved upwards and attenuated at the apex; the second elongated, somewhat attenuated, the terminal rather short, subovate, obtuse: *maxillæ* slender, and very short.

Head rather small, with a dense tuft before the antennæ: *eyes* globose, naked.

Thorax subquadrate, with a compressed acute crest in front.

Abdomen elongated, the sides producing fascicles of scales, robust in the females, and obtuse at the apex, which is rather broad, and has a subquadrate tuft in the males.

Larva fleshy, slightly hairy, radicivorous: *pupa* internal†.

Species.	Icon.
1. Gort. *Leucostigma*, Hüb.‡	Ernst, VI. Pl. CCLV. f. 389.
2. — *Micacea*, Esper...	Ernst, VII. Pl. CCLXI. f. 407. Curtis, Brit. Ent. VI. Pl. 252.
3. — *Flavago*, Hübn....	Ernst, VII. Pl. CCCII. f. 517.
4. — *Luteago*, Fab..	Ernst, VI. Pl. CCL. f. 372.

Genus 71. XANTHIA§, *Ochs.*, *Treitsch.* (Steph., Curtis.)

XANTHIÆ, Hübner.

Wings entire, or crenulated, deflexed during repose: anterior subtriangular; posterior moderate.

* LEUCANIA, Steph.?

† Characters chiefly from Stephens. *Haust.* III. 69.

‡ APAMEA, Steph.

§ *Ξανθος, yellow.*

Antennæ

Antennæ rather stout, long, simple in both sexes, pubescent, ciliated transversely beneath in the males.

Palpi rather short, obliquely porrected, thickly clothed with elongate scales; the terminal joint slightly exposed and obtuse, basal joint less than half the length of the second, rather slender at its base, curved upwards, second very long, attenuated and somewhat acute at the apex, terminal elongate, apex slightly conic: *maxillæ* as long as the antennæ.

Head, round, small: *eyes* naked.

Thorax somewhat robust, slightly crested.

Abdomen moderately stout, carinated in the males, cylindric and rather acute at the tip in the females, with a small tuft at the apex; sometimes depressed in both sexes, with the sides slightly reflexed.

Larva naked: *pupa* subterranean*.

Ochsenheimer and Treitschke divide this genus into three families, according to the colours and markings of the anterior wings.

FAM. A.—Anterior wings brown-yellow, with darker confluent spots.

FAM. B.—Anterior wings reddish-yellow, with distinct transverse bands.

FAM. C.— Anterior wings bright yellow (*schön gelbon*) with reddish-brown transverse bands; posterior wings light coloured.

FAM. A. Species.	Icon.
1. Xanth. *Pulmonaris*, Hüb.	Hübn. Noct. Tab. 20. f. 98. (mas.)
2. — *Echii*, Hübn......	Ernst, VII. Pl. CCXC. f. 488.
3. — *Ochroleuca*, Hubn.	Hübn. Noct. Tab. 19. f. 92.
FAM. B.	
4. Xanth. *Rufina*, Linn....	Ernst, VII. Pl. CCLXI. f. 410.
5. — *Ferruginea*, Hübn.	Ernst, VII. Pl. CCLXI. f. 408. a. b.
6. — *Evidens*, Hübn....	Hübn. Noct. Tab. 79. f. 369. (mas.)
7. — *Rubecula*, Esp....	Hübn. Noct. Tab. 92. f. 431. (mas.)
8. — *Xerampelina*, Hüb.†	Hubn. Noct. Tab. 90. f. 421. (fœm.)
FAM. C.	
9. Xanth. *Vitellina*, Hüb.	Ernst, VII. Pl. CCXCVIII. f. 506.
10. — *Citrago*, Linn......	Ernst, VII. Pl. CCCV. f. 527.
11. — *Croceago*, Fab.....	Ernst, VII. Pl. CCCII. f. 518.
12. — *Aurago*, Fab.......	Ernst, VII. Pl. CCCIII. f. 520.
13. — *Sulphurago*, Fab.	Hübn. Noct. Tab. 41. f. 194. (mas.)
14. — *Silago*, Hübn......	Ernst, VII. Pl. CCCIV. f. 524.

* Characters from Stephens. *Illust. Brit. Ent. Haust.* III. p. 63.

† Add, Xanth. Centrago, (The centre-barred Sallow,) *Haw. Curtis Brit. Ent.* II. Pl. 84.

Species.	Icon.
15. Xanth. *Cerago*, Fab. ...	Ernst, VII. Pl. CCCIV. f. 523. a—d.
16. — *Gilvago*, Fab......	Ernst, VII. Pl. CCCIV. f. 523. e.
17. — *Palleago*, Hübn...	Hübn. Noct. Tab. 94. f. 442. (mas.)

Genus 72. COSMIA*, *Ochs.*, *Treitsch*, (Stephens.)

Cosmiæ, Hübner.

Wings deflexed during repose; *anterior* subtriangular, slightly truncate or obscurely emarginate on their hinder margin, with distinct angular strigæ; *posterior* rather ample.

Antennæ short, rather slender, pubescent within, each articulation furnished with a bristle on each side, shortest in the females.

Palpi moderate, ascending, densely clothed with elongate scales on the two basal joints, the terminal exposed, somewhat acute; basal joint elongate, nearly three-fourths the length of the second, arcuated, the second scarcely more slender than the first, linear, and somewhat bent at the base; terminal more slender, elongate, above half the length of the second, slightly attenuated at the apex, which is acute: *maxillæ* moderate.

Head small, rounded: *eyes* large, globose, naked.

Thorax stout, not crested.

Abdomen rather slender, with tufts of hair on the sides, and a larger tuft at the apex, especially in the males, of the females gradually attenuated from the base to the apex, which is somewhat acute.

Larva naked, with a few scattered hairs: *pupa* subterranean †.

Species.	Icon.
1. Cosm. *Fulvago*, Hübn.	Ernst, VII. Pl. CCCV. f. 526.
2. — *Abluta*, Hübn.....	Hübn. Noct. Tab. 76. f. 351. (fœm.)
3. — *Trapezina*, Linn.	Ernst, VIII. Pl. CCCXIII. f. 546.
4. — *Diffinis*, Linn.....	Ernst, VIII. Pl. CCCXI. f. 543.
5. — *Affinis*, Linn.......	Ernst, VIII. Pl. CCCXII. f. 544.
6. — *Pyralina*, Hübn..	Ernst, VIII. Pl. CCCXII. f. 545.

Genus 73. CERASTIS, *Ochs.*, *Treitsch.*

Glææ, Hübner. Glæa, Stephens, Curtis.

Legs moderate; *femora* not very pilose.

Wings generally entire, incumbent; *anterior* more or less castaneous.

Antennæ rather long, stout, generally simple in both sexes, and ciliated; sometimes a little serrated in the males.

* Κοσμιος, *modestus*.

† Characters from Stephens. *Haust.* III. p. 59.

Palpi

Palpi very short, porrect, horizontal, triarticulate, not very robust, clothed with elongate scales, the terminal joint concealed; the basal joint nearly as long as the second, a little bent, the second more slender than the first, slightly curved, and narrowed towards the tip; terminal joint ovate, obtuse: *maxillæ* shorter than the antennæ.

Head small, with a dense tuft of hair between the antennæ: *eyes* small, naked.

Thorax stout, pilose, with an abbreviated dorsal tuft towards the front.

Body generally depressed, with the sides and apex considerably tufted.

Larva naked, or slightly hairy: *pupa* subterranean *.

Treitschke divides this genus into three families.

FAM. A.—Larva naked, variegated.

FAM. B.—Larva hairy, dark coloured.

FAM. C.—Larva naked, body dark coloured, with generally lighter longitudinal lines.

Both Stephens and Curtis have very properly restored Hubner's name, Glæa, to this genus, which Treitschke, for some unknown reason, has thought fit to change to Cerastis, a term already employed to designate a serpent.

FAM. A. Species.	Icon.
1. Cer. *Rubricosa*, Fab....	Ernst, VII. Pl. CCCI. f. 513.
FAM. B.	
2. Cer. *Rubiginea*, Fab....	Ernst, VII. Pl. CCC. f. 512.
FAM. C.	
3. Cer. *Ruticilla*, Esper. ..	Hubn. Noct. Tab. 104. f. 488. (mas.) f. 489. (fœm.)
4. — *Vaccinii*, Linn....	Ernst, VII. Pl. CCCI. f. 514.
5. — *Erythrocephala*, F.†	Ernst, VII. Pl. CCXCIX. f. 507. a.
6. — *Dolosa*, Hübn.....	Ernst, VII. Pl. CCCI. f. 515. c. et f. 516. a.
7. — *Glabra*, Hübn....	Ernst, VII. Pl. CCXCIX. f 510. a.
8. — *Silene*, Fab........	Ernst, VII. Pl. CCLXV. f. 417.
9. — *Satellitia*, Linn...	Ernst, VII. Pl. CCC. f. 511.
10. — *Serotina*, Treitsch.	Ernst, VII. Pl. CCLXXI. f. 431.

Genus 74. XYLINA, *Ochs.*, *Treitsch.*

XYLINÆ, Hübner.

XYLINA, CALOCAMPA, XYLOPHASIA, PETASIA, DYPTERIGIA, HADENA, CHARICLEA, Stephens.

XYLINA, CHARICLEA, Curtis.

* Characters from Stephens. *Haust.* II. p. 159.

† GRAPHIPHORA? Stephens.

Wings

Wings very long and sublinear; *superior* with the cilia indented; *inferior* rather large.

Legs, *anterior* short, *posterior* long; *femora* very large and woolly: *anterior tibiæ* very short, with an internal scaly spine; *posterior* very long, terminated by spurs, and a pair above the apex: *tarsi* with series of spiny scales beneath, 5-jointed, anterior joint very short, basal the longest: *claws* distinct, slightly notched near the middle: *pulvilli* minute. *Antennæ* setaceous, robust in the males, thickly clothed with obtuse scales above, each joint ciliated with hairs beneath.

Palpi short, robust, porrected obliquely, densely covered with scales, which conceal the apical joint; triarticulate, basal joint robust, 2nd long, slightly dilated in the middle, 3rd oval-truncate.

Head very short, closely united to the thorax, and densely covered with long scales: *eyes* small.

Thorax quadrate, slightly crested.

Abdomen short, depressed, the apex, in the males, triangular.

Larva cylindrical, naked*: *pupa* folliculated, its apex unidentate. (Stephens.)

Treitschke (whose concise definition of this genus, Mr. Stephens justly remarks, is so truly general and indefinite that it will include a host of species that he has placed elsewhere) has divided the insects included under his Xylina, into four families.

FAM. A.—Anterior wings long, and narrow; body depressed. Larva green or brown; corrugated.

FAM. B.—Anterior wings rather broader and shorter; body less depressed. Larva tuberculated.

FAM. C.—Wings and body densely scaly. Antennæ of the males pectinated. Larva green; the 11th segment of the body tuberculated.

FAM. D.—Anterior wings marbled, the markings intersected longitudinally with brighter lines. Larva variegated, and like parchment! (*pergamentartig.*)

FAM. A. Species.	Icon.
1. Xyl. *Vetusta*, Hübn.†..	Ernst, VI. Pl. CCXLIX. f. 370. b.
2. — *Exoleta*, Linn.†...	Ernst, VI. Pl. CCXLIX. f. 370. a. c. f. g. h.
	Curtis, Brit. Ent. Pl. 256. Larva et Imago.

3. Xyl.

* Characters from Curtis. *Brit. Ent.* VI. pl. 256.

† CALOCAMPA, Steph.[a]

"*Palpi* short, oblique, robust; triarticulate, densely squamous, the terminal joint

[a] Καλη pulchra, καμπη eruca.

Species.	Icon.
3. Xyl. *Solidaginis*, Hübn.	Noct. Tab. 53. f. 256. (fœm.)
4. — *Conformis*, Fab....	Ernst, VI. Pl. CCXXXVI. f. 343.
5. — *Zinckenii*, Treitsch.*	— — —
6. — *Lapidea*, Hübn...	Hubn. Noct. Tab. 82. f. 382. (mas.)
7. — *Rhizolitha*, Fab...	Ernst, VI. Pl. CCXI. f. 284.
8. — *Petrificata*, W. Verz.	Ernst, VI. Pl. CCL. f. 371.
9. — *Conspicillaris*, Linn.	Ernst, VI. Pl. CCLIII. f. 382.
10. — *Putris*, Linn.......	Ernst, VI. Pl. CCLI. f. 376.
11. — *Erythroxylea*, Treitsch.†	— — —
12. — *Puta*, Hübn.......	Hübn. Noct. Tab. 52. f. 55. (fœm.)
FAM. B.	
13. Xyl. *Scolopacina*, Hüb.‡	Ernst, VI. Pl. CCLI. f. 377.
14. — *Rurea*, Fab.‡......	Ernst, VI. Pl. CCL. f. 373.
15. — *Hepatica*, Fab.....	Ernst, VI. Pl. CCLI. f. 375.
16. — *Polyodon*, Linn.‡..	Ernst, V. Pl. CLXXXVIII. f. 245. a. b.
17. — *Lateritia*, Esper...	Hübn. Noct. Tab. 15. f. 74. (fœm.)
18. — *Lithoxylea*, Fab.‡	Ernst, VI. Pl. CCLI. f. 378.
19. — *Petrorhiza*, Borkh.	Ernst, VI. Pl. CCXI. f. 283.

joint concealed, basal much shorter than the second and more robust, terminal ovate truncate: *maxillæ* the length of the antennæ. *Antennæ* rather short, stout in the males and ciliated beneath: *head* small, with a dense frontal crest: *eyes* naked, small: *thorax* quadrate, with a small anterior crest: *wings* convoluted or incumbent; anterior elongate, sublinear, denticulated on the hinder margin: *body* short, depressed, the apex with a small tuft in the male. *Larva* smooth: *pupa* folliculated, with two elongate spines at the apex."—*Steph. Illust. Brit. Ent. Haust.* II. p. 172.

* Xyl. alis anticis cinereo albidoque marmoratis, lineolâ baseos atrâ, albo inductâ, maculis ordinariis albidis, nigro cinctis, lineâ marginali interruptâ.—*Ochs., Treitsch.* V. *pars* III. p. 16.

† Xyl. alis anticis ex flavo albidis, margine anteriori externoque rufescentibus, maculâ reniformi obscuriore.—*Ochs., Treitsch. l. c.* p. 31.

‡ XYLOPHASIA, Steph.

"*Palpi* rather elongate, slightly ascending; triarticulate; the two basal joints densely clothed with elongate scales, the terminal considerably exposed; the basal joint rather shorter and more robust than the second, the terminal elongate-ovate, somewhat acute: *maxillæ* as long as the antennæ. *Antennæ* simple, more or less ciliated or pilose, in the males; *thorax* quadrate, with a small crest in front: *wings* deflexed, anterior rather elongate, subtriangular, the base being narrowed; hinder margin more or less denticulated: *body* elongated, stout, not depressed, the back carinated, each segment with a dorsal crest; apex, in the male, with a large tuft, in the female, narrowed, sublinear, with a small tuft. *Larva* naked: *pupa* subterranean, with a spine at the apex."—*Steph. Illust. Brit. Ent. Haust.* II. p. 174.

---

[a] Ξυλον *lignum*, Φασις *apparitio*.

20. Xyl.

Species.	Icon.
20. Xyl. *Pulla*, Hübn......	Hübn. Noct. Tab. 49. f. 238. (mas.)
Fam. C.	Tab. 150. f. 692. 693. (fœm.)
21. Xyl. *Cassinia*, Fab. *..?	Ernst, V. Pl. CXCIV. f. 255.
22. — *Nubeculosa*, Esper.	Ernst, Suppl. Pl. I. f. 172. a—i.
23. — *Pinastri*, Linn. †...	Ernst, VII. Pl. CCLXXX. f. 458.
24. — *Rectilinea*, Hübn ‡.	Ernst, VI. Pl. CCLIV. f. 385.
25. — *Ramosa*, Hübn...	Ernst, VI. Pl. CCLIV. f. 384.
26. — *Lithorhiza*, Borkh. §	Ernst, VI. Pl. CCXIII. f. 290.

27. Xyl.

* Petasia, Steph.[a]

"*Palpi* short, compressed, straight, very hairy, biarticulate, the terminal joint ovate, subacute: *maxillæ* nearly obsolete. *Antennæ* elongated, bipectinated to the apex in the males, subserrated and ciliated in the females: *head* moderate, hairy, with two fascicles of elongate scales at the base of each antenna: *thorax* not crested; *abdomen* slightly elongated, scarcely tufted at the apex: *anterior wings* elongate, entire, with a patch of elongate scales in the middle of the interior edge: *posterior* subovate: *breast* and *femora* very downy; *anterior tibiæ* with a compressed lobe internally; and an acute, bent, glossy spine exteriorly; the *posterior tibiæ* with spurs at the apex. *Larva* naked, fleshy, with the anal segment gibbous: *pupa* subterranean."—*Steph. Illust. Brit. Ent. Haust.* II. p. 31.

† Dypterygia, Steph.

"*Palpi* conspicuous, ascending, slender, triarticulate; the two basal joints clothed with elongate scales, the apical joint considerably exposed, covered with short scales, linear, and as long as the basal one, which is slightly bent and more robust than the second; the latter is about one half as long again as the first, slightly attenuated towards the apex: *maxillæ* moderate. *Antennæ* very short, rather stout, simple in both sexes, ciliated within and pubescent in the male: *head* slightly crested; *eyes* small, naked: *thorax* robust, thick, crested on the back: *wings* incumbent; *anterior* short, broad, subtriangular, subdentate; *posterior* ample: *body* rather stout, crested on the back: *legs* short; *posterior tibiæ* robust, compressed, with a fascicle of hair on the outer edge. *Larva* naked, with a conical protuberance on the anal segment: *pupa* folliculated, with four apical spines."—*Steph. Haust.* II. p. 167.

‡ Xylophasia, Steph.

§ Hadena, Steph.

Although we have already given the genus Hadena (the 54th of Treitschke's arrangement), we shall add in this place the characters assigned to it by Stephens, which had not appeared when that part of our abstract containing this genus was published.

Hadena. "*Palpi* short, rather slender, slightly ascending, clothed with hair and scales, triarticulate; terminal joint rather exposed, short, subovate; the basal joint curved, in general rather shorter and stouter than the second, which is a little attenuated towards the apex; terminal subovate, obliquely truncate: *maxillæ* about the length of the antennæ. *Antennæ* short, rather stout, in general simple, with the under side ciliated in the males, or obscurely subserrate, with a distinct fasciculus of hair on each joint within: *head* small, with a dense frontal crest; *eyes* large, globose, sometimes pubescent: *thorax* slightly crested: *body* stout, rather elongate, very acute in some females:

[b] Πετάζω *pando.*

Species.	Icon.
27. Xyl. *Hyperici*, Fab.. ...	Ernst, VI. Pl. CCXLII. f. 357.
28. — *Perspicillaris*, Linn.	Ernst, VI. Pl. CCXXXVI. f. 345.
29. — *Platyptera*, Esper.	Ernst, VII. Pl. CCXCI. f. 490.
30. — *Radiosa*, Esper....	Hübn. Noct. Tab. 92. f. 434. (fœm.)
31. — *Antirrhini*, Hübn.	Ernst, VI. Pl. CCXXXVII. f. 347. e. f.
32. — *Linariæ*, Fab.. ...	Ernst, VI. Pl. CCXXXVII. f. 347. a—d.
33. — *Opalina*, Hübn...	Hübn. Noct. Tab. 81. f. 376. (fœm.)
34. — *Delphinii*, Linn.*	Ernst, VIII. Pl. CCCX. f. 538. Curtis, Brit. Ent. II. Pl. 76. Larva et Imago.

[To be continued.]

XXIX. *A Letter to* J. E. Bicheno, *Esq.*, *F.R.S.*, *in examination of his Paper "On Systems and Methods" in the Linnean Transactions. By* W. S. MacLeay, *Esq.*, *A.M.*, *F.L.S.*, *&c.*†

My dear Sir,

I HAVE read your Paper "On Systems and Methods," in the Linnean Transactions‡, with some degree of interest, as it derives no small importance from being, as every word shows, clearly written *ex cathedrâ*. With a few exceptions, which I should hope have proceeded from inadvertency, it is, moreover, upon the whole, a liberal exposition of the opinions pre-

males: *wings* slightly deflexed during repose; *anterior* obscurely denticulate on the hinder margin: in general of gay colours, sometimes with pale reticulations, and mostly with a pale undulated striga, in which is usually a conspicuous angulation, resembling the letter W, near the posterior margin; *stigmata* distinct; *posterior wings* with an obscure emargination towards the costa: *larva* naked, generally of lively colour: *pupa* subterranean."—*Steph. Haust.* II. p. 179.

* Chariclea, Steph. Curtis.

"*Antennæ* long setaceous, composed of numerous short joints covered with scales above, hairy beneath, 1st joint large, concealed by long, hairy scales. *Labrum* and *mandibles* attached to the clypeus. *Maxillæ* nearly as long as the body, with a few glands like tentacula towards the apex. *Labial palpi* rather short, curved upward, covered entirely with long hairy scales, 3-jointed, 1st joint long, cylindric, 2nd shorter, somewhat ovate, 3rd small ovate. *Head* trigonate viewed from above. *Abdomen* without tufts of scales, apex of the male slightly bifid. *Wings* deflexed, superior somewhat lanceolate, inferior rather small. *Cilia* very long. *Legs* clothed with soft hair, anterior rather short. *Tibiæ*, anterior very short, trigonate, with 2 horny naked spines at the apex, the internal one being very long and curved. *Tarsi* 5-jointed, armed with rows of spines beneath, 1st being very long. *Claws* minute, bifid. *Pulvilli* distinct. *Caterpillars* with 6 pectoral, 8 abdominal and 2 anal feet."—*Curtis, l. c.*

† From the Zoological Journal, vol. iv. p. 402.

‡ Vol. xv. p. 471.—See Phil. Mag. and Ann. vol. iii. p. 213.

valent

valent among the Naturalists of the old Linnean school. True it is, you think it necessary to show your impartiality, and to bestow some censure *en passant* on this school, but it requires no great penetration to see that your Paper was intended for their peculiar circle, and I therefore earnestly trust that your labours may not go unrewarded, and that you may obtain all the honour and glory which you promised yourself from the staunch Linneans, by this publication.

I know enough of you to be convinced, that although, from the style of your Paper, you seem to wish to lay down your "principles of arrangement" oracularly, still, rather than that your laws should be wholly slighted, you would be most willing, nay, desirous to have them well sifted and examined. I am convinced, I repeat, that you have too firm an opinion of their soundness to believe for a moment, that they will not come like pure gold from any crucible in which they may be assayed. Perhaps other friends who have the pleasure of being nearer to you, have long ere this shown you your mistake; but in case they have not, I am sure that you will not be surprised that I should have determined to state how far I feel myself called upon to agree with you in opinion.

My review of your paper must be premised with the remark, that I do not pretend to combat the general conclusion to which it is your object to arrive; for I confess, that after having twice carefully read over your argument, I am not sure that I understand its drift, and much less am I certain, that if I did understand it, your sentiments would differ considerably from my own. If, however, the purport of your Paper be, as there is some reason to suspect, comprehended in the assertion, that "the danger to be now apprehended is, that those who adopt other arrangements" than the Linnean, "will forget the advantages to be derived from what is old in their love of that which is new," then I would once for all observe, that there never was a time when Naturalists paid more attention to the labours of their predecessors, whether ancient or modern, than at present: and therein indeed consists a part of their diagnosis, as you would perhaps express it, from the school which you advocate; and which in its love and veneration for what is not old, but only Linnean, remains in a total and complete ignorance of whatever has not proceeded from the pens of the Swede and his most servile admirers.

Still, nevertheless, since I remain in doubt as to this being the object you had in view in writing on Systems and Methods, I shall confine myself strictly to those of your propositions which I think most difficult to assent to, leaving the general conclusion at which you would arrive, unless it be as above,

above, untouched, until you shall have, at some future period, more clearly expressed it.

You say that you are not yourself opposed to any particular system, but only intend in your Paper to lay down some "*first principles of arrangement*," to serve as a test by which Naturalists may try all systems. Let us, however, examine calmly these "first principles" themselves, before we apply them; for the test of a system ought surely to be proved good and true before we can allow it to regulate either our assent or dissent.

In the first place, you propose to treat the subject metaphysically, as a Locke, not as a Linnæus. Now to this proposal no Naturalist ought to object, provided you found your metaphysical arguments, and "abstract reasoning," on some little observation of Nature, and provided you illustrate your various positions by facts drawn from Natural History. How far your Paper is strictly logical or metaphysical, I will not now discuss; but I will venture to say that your abstract reasoning would have carried much more weight with it, had you seasoned it a little more with illustrations drawn from observed facts.

You are pleased, upon the authority of Mr. Roscoe and Sir J. Smith, which you very naturally esteem quite conclusive, to state to those who break up the old genera into many new ones, "that the artificial and natural systems aim at two very distinct objects." Although in these degenerate days it is not very usual to talk of the natural system as *aiming at an object*, I imagine that I understand what you would say, in which case the information you would impart is not very original either from your botanical authorities or yourself; nor am I aware exactly for whom you are charitable enough to intend it, as I know of no Naturalist who does *break up*, at least in your sense of the words, the old orders and genera when he deems them good. I say *in your sense of the words*, for I must suppose you mean your advice for those who destroy or take no notice of the ancient groupes. You cannot surely, with your talents for abstract reasoning, mean to attack those who not merely preserve them, but by subdivision make us by the consequent analysis better acquainted with their internal construction. A person who retains the groupes of the older Naturalists, and moreover shows us how these may be resolved again into others, evidently possesses a greater portion of that acquaintance with individual forms upon which our knowledge of the natural system must, as even you yourself allow, eventually be grounded. I cannot believe that you, who profess to understand the exact portion of merit that be-

longs respectively to the various schools of Naturalists, now require to be informed that those of the present day make it a rule to preserve the ancient groupes where they deem them good, and only differ from their predecessors in showing how these groupes may be subdivided. This, in fact, is the real progress of Natural History; for on looking back at the mode for instance, in which Zoology has advanced, we find that Aristotle's Genera were the Orders of Linnæus, and that the Genera of Linnæus are the Families of the present day. And not only the word *genus*, but even the word *species*, as you yourself say, has become more confined in its signification. To say that the word *genus* had originally any confined or determinate sense given to it by Linnæus, or that any particular limits were assigned to it by him, beyond that perhaps of its being his smallest known groupe of species, is sufficiently disproved, not only by the impossibility of his making it to signify any thing else than a groupe, but also by the fact, that the learned Swede was constantly, as his knowledge of individuals increased, subdividing his early genera into new ones. But however this may be, I beg you may rest assured that every person who goes on increasing his acquaintance with the smaller natural groupes, whether they be called *genera*, or *subgenera*, or any thing else, must know but too well that artificial systems aim at a different object from the natural system. I should have fancied, indeed, that so much was implied by the bare use of such terms as *natural* and *artificial*.

An artificial system aims at facilitating the distinction and nomenclature of species, and not at the knowledge of how these species are connected together in the one great plan of creation, which in fact is *the natural* system. An artificial system, therefore, really aims at an object; but the natural system is itself the object aimed at by those, who truly know the difference between the two, and how trivial and contemptible the most perfect acquaintance with the one is in comparison with the smallest glimpse of the other. But you state that the natural system has an object, namely, "to abridge the labour of reasoning!" If I know what is meant by the Natural System, it is as I have already stated, the original plan of the creation; and to say, therefore, that the object of the natural system, or rather of the Deity who devised it, was to abridge the labour of reasoning, is beyond my comprehension, and still less can I understand how it answers to the purpose thus assigned to it. I suspect, indeed, the longer you study it, the less you will find your labour abridged. At least such is the recorded experience of men who have dealt as much in the observation of facts as in abstract reasoning.

You

You favour us with the Linnean definition of a *species*, and then think proper to throw doubt on its accuracy, because, as I conceive, you happened not at the moment to turn over a page or two more of the *Philosophia Botanica*. I am not sufficient Botanist, perhaps, to understand the difficulties which appear to have beset you in the particular department of Natural History which you have studied; but I may state, that when similar difficulties occur in Zoology, and species are ascertained "*to run one into another*," we are accustomed to doubt the fact of their being distinct species; we call them *varieties*, and search for some general characteristic which will include and insulate the whole of these varieties, and then call that the specific character. If I may trust the evidence of my eyes, the White and Negro races of the human species "run into one another by imperceptible shades unappreciable by human sense, so as to render it impossible to circumscribe them." Nay, there are "empirical characters" which distinguish even a Frenchman from an Englishman, and "which can only be perceived by long and familiar experience, and cannot be described by words; yet no one hitherto has been bold enough to declare them distinct species. It seems, nevertheless, that there are certain persons "who think it advisable to break up" the old species into many new ones; but you evidently consider such persons as angels in comparison to the wretches who would dare to subdivide a Linnean genus, a crime which you have ever held in the utmost abhorrence. Yet, as I understand the matter, if there be any groupe in Natural History more truly insulated than another, it is a species; and the division of this natural groupe of individuals ought scarcely, therefore, to be less blamed than that of a genus which may have only rested on the good pleasure or ignorance of Linnæus, or on that of some blind worshipper of his infallibility. Not indeed that I would have those poor species-makers attacked; for I care very little one way or the other about them, although for all that I know, even they may be doing good in their generation, by pointing out differences.

By the bye, on the subject of Species you settle the question by deciding that "in cases of difficulty the assumed law ought to be brought to the test of experiment, or the species should be rejected." Now I find it to be a case of some difficulty to understand this advice, since on looking back, the only "*assumed law*" I can perceive mentioned is as follows: "A species shall be that distinct form originally so created, and producing, by certain laws of generation, others like itself;" and unfortunately you have forgotten to inform us how we are to ascertain by experiment, "a distinct form originally so created.'

ated." This, however, is clearly the essential characteristic laid down in the law, since a Negro "produces by certain laws of generation others like himself," and yet is not very generally accounted to be a distinct species. But I ought to recollect, that in spite of Mr. Wilberforce, you have your doubts on this particular point: that in fact it still remains with you "the most difficult problem of all."

You lay down as a "first principle of arrangement," that "in Botany the characters of a Genus should be taken from the parts of fructification, and in Zoology from such parts as are indicative of structure and habits." Having myself, as you know, dabbled a little in Zoology, and being pleased with the sight of a really new definition, I am anxious to learn what other zoological parts remain, in order that I may avoid them.

To clear up the fog in which our poor brains are enveloped when we attempt to distinguish a species from a genus, you next inform us that "there is the same difference between a genus and a species as instruments of reasoning, as between a definition and a proposition in geometry." Now the difference between the latter is, that the proposition requires demonstration, and the definition not. I must therefore suppose that this mode of illustration is "*ut lucus a non lucendo*," for you have just before declared that species must "be brought to the test of experiment," in other words, must be demonstrated.

It appears you do not regard genera as merely conventional, but as actually founded in nature, as well as species. I likewise consider genera *when properly defined*, to be founded in nature, as I have elsewhere said;* but I have not found even these natural genera, upon the whole, to be so distinctly insulated from each other as species. I will now, however, go further than you, by stating that the groupes you object to, such as Class, Order, Tribe, Cohort, and Family, are, when properly defined, just as natural as Genera; and also that the higher we ascend in the scale, and the more comprehensive our groupes are, we may, in general, be assured, that in the same proportion they are perhaps even more natural. Thus, who will assert that Animals form a less natural groupe than Vertebrata, Vertebrata than Mammalia, Mammalia than Cetacea, or these last than the genus Balæna? Even Linnæus, the infallible Linnæus, speaks of natural classes and natural orders as distinct from artificial ones. No one, till now, has ventured to call the classes of Mammalia, Birds and Fishes, or the orders Lepidoptera, Coleoptera and Diptera, "*gratuitous assumptions.*" Your doctrine, therefore, is really original;

* See Horæ Entomologicæ, page 490.

but

but at the same time it is rather surprising that the recognized organ of the Linnean Society should publicly, in the Transactions of that learned body, state that the above "different gradations are gratuitous assumptions with which Nature has nothing to do;" and that pursuing this doctrine, he should object, not merely to those who would "attempt to express with more accuracy larger generalizations than they would do by employing a generic term," but also bestow censure on those "who think it advisable to break up the old genera into new ones." In short, we must remain stationary, according to you, with neither greater nor less groupes of species than the genera of Linnæus and Sir James Smith. All other assemblages of approximations, and approximations of assemblages, "are rather predicated than proved;" and in future we are only to be permitted by you "to point them out by mere signs, such as are used in printing," by asterisks, forsooth, and obelisks, or a casual dagger. Such is the perfect vehicle which in future is to convey with precision the just relation of things! I trust that you will favour us yourself with a specimen of it, and show that you know how, by example, to enforce your precepts.

You do not seem to think those persons who regard genera subject to be broken down to suit their convenience, as entitled to make use of the word Genus. It is a downright robbery on their part. "They would do well to employ some other term, else one great object will be lost at which we are aiming;—the keeping together under one common head those small assemblages of species which in some instances are so obvious and so important." On this head I experience great pleasure in being able to allay your fears, and to assure you that they do keep together under a common head, all those small assemblages of species which they conceive to be obvious; and that they even go further (too far you will say), and keep together the large assemblages also.

I now come to one of those illustrations with which you have so sparingly sprinkled your Paper, no doubt from reluctance to increase its bulk; and I find that "it would be the height of folly to give up the term of Genus for such insulated groups as Erica, Rosa, and Eriocaulon among plants, and Vespertilio, Strix, and Scarabæus among animals." If there be pleasure in being able to meet you on a known arena, I may also be expected to experience fear in having to defend myself against one who enters the lists so cavalierly. There is nothing like presenting an imposing front on the first attack where boldness is often of more avail than strength of weapons. No doubt it was from contempt for a strong example, that you chose your present zoological weapons, and therefore

it would be presumption in me to tell you that upon a little deeper acquaintance with Zoology, you will see that neither Vespertilio, Strix, nor Scarabæus, as defined by Linnæus, are insulated groupes. As to Scarabæus, indeed, I should be glad to know by what characters you would insulate it. I happen to have seen more than 2000 species of the Linnean genus Scarabæus, when Linnæus himself saw little more than 80. I suspect, therefore, that I have given quite as much time and attention to the consideration of this Linnean genus as you, although you, by a species of intuition, have got the start of me. This must be my apology for daring still to brave your polite imputation of having arrived at the acme of folly, and for still imagining that I have done some service to Entomology in helping to subdivide so immense a groupe. You are truly the first of naturalists, and I dare say will also have the honour of being the last, who has written on Scarabæus, and pronounced it to be an insulated groupe. Perhaps it was from their being so little abstract, and their descending so low as to study the subject in nature, that those plodding entomologists, Fabricius and Latreille, have had such difficulty in finding a place for Sinodendron, Lethrus, &c., &c. As you profess, two or three pages after, to look at Entomology with the eye of a master, and to point out the difficulties and defects of the science, you could not surely be ignorant that Fabricius, whom Linnæus called his master in Entomology, that Latreille, Olivier, and Kirby, that in short every modern Entomologist who does not belong to what may be termed the defunct or dying Linnean school of England, has found it necessary to subdivide the Linnean genus Scarabæus. The chair, therefore, of the Secretary of the Linnean Society, must be placed on some peculiarly high eminence, when it entitles a gentleman on the strength of having described three species of Orchis, and perhaps twice as many Rushes, to dismiss all Entomologists subsequent to Linnæus with the compliment of being a pack of fools.

It is to be regretted, that so oracular an authority on Systems and Methods should not have shown wherein they differ from each other. It only remains for me, therefore, in the investigation of your "first principles of arrangement," to ascertain what distinction you, who are so apt to charge dissenters from your maxims with the height of folly, make between artificial systems and the natural one. It would be curious, if he who blames others "for not fully appreciating the difficulty of this subject," should happen to have promulgated his principles before he had made himself acquainted with the above distinction.

You

You say "division and separation is the end of the Artificial System;" and as I know not what particular artificial system you allude to, far be it from me to say that you may not possibly be in the right. But then you proceed as follows:— "To establish agreements is the end of the Natural System." Now that you who kindly offer to "prevent young Naturalists from being prematurely embarrassed in this difficult subject," should thus express yourself, surprises me not a little; for I had always understood that so far from the natural system having for its object to establish agreements, its agreements have remained established from the time of the creation. I will not suppose that a writer "on systems and methods" could have forgotten to make himself master of the very keystone of his subject, and that he can still remain ignorant of the Natural System itself being the end or object at which we aim, and not an instrument like any artificial system to arrive at an end. It is no doubt for the purpose of displaying your powers of abstract reasoning that you advance such positions as the above, or that you state that the Artificial System is a *descending* series, and the Natural System an *ascending* one. Nay, what is more extraordinary than all, you seem in another place to imagine, that there are more natural systems than one, and that a variety of them have been already attained by the Linnean Society; for you advise us to "*take any* natural system, and see if this," &c. Pray let me know where I shall find one of them, and I shall be content. It excites your surprise that "many modern Naturalists have not adopted your truths," but you ought to have recollected that the many are not so far advanced as yourself. They have been looking for one natural system, *only one*, and confined as their aim is, they have not as yet been able to attain it.

"It is the prevalent error of modern Naturalists to attempt to generalize where they ought to analyse, while their arrangements called natural, are almost all framed with a view to distinguish." Metaphysically, perhaps, this passage is very clear; but what, in the name of plain sense, is the meaning of it? Modern Naturalists err in refraining to analyse, and also err, inasmuch as they are all busy distinguishing! Perhaps, however, after all, there is consistency in this paradox; for we have seen that you censure as well those who subdivide the Linnean genera as those who combine them into larger groupes. It was possible, nevertheless, for you to have expressed yourself with greater clearness, if this be really the meaning of so contradictory and curious a sentence.

You next draw "a diagnosis" between M.M. Brown and Decandolle, which, because perhaps I am no Botanist, I cannot

not pretend altogether to understand; for the latter is blamed for "attempting fresh *combinations* at every stage," and the former praised "as his object is chiefly *synthesis*." I am the more sorry for my ignorance of the botanical difference between *combination* and *synthesis*, not merely because I have myself the highest opinion of Mr. Brown's science, but because I of course must feel interest in any eulogy of our friend by those who, as Botanists, must be best able to judge of his merits.

I have already hinted, that your distinction between the natural and an artificial system, making the latter a descending series, and the former an ascending one, could have only been maintained by you from love of paradox; but as you return to this distinction, and may therefore possibly believe it correct, I shall explain myself more fully. Both kinds of system afford ascending and descending series. It is clear, for instance, that the Linnean sexual system in Botany was in the first case founded as much on the examination of individuals as if it had been the natural system. In studying, therefore, any system, whether natural or artificial, we must always begin with individuals, and look upwards, discovering first the species, next the genus, and so on. It is true, indeed, that *the genus* may have been a more comprehensive groupe with early Naturalists than with modern; but however this may be, the above is the general process of investigation. Nay, it so happens, that this system of combining has hitherto been pursued principally in various artificial systems, although the searchers after the natural system have no reluctance to apply the knowledge of natural groupes, that happens sometimes to be thus acquired, to their own more particular object. In the same way the natural system is not essentially an ascending series, for it is equally true, whether it ascends or descends; being equally the plan of the Deity, however we may please to study it, whether by analysis or synthesis.

Next you say, "If we find a large genus agreeing in some well-marked characters of structure, form, station, and properties, it appears contrary to the end proposed by the natural system to divide and subdivide the species into small groups, and to give each of these the same value as is now possessed by the whole. This is frittering away characters which are essential to the use of a genus, and destroying our power over it when we wish to generalize." On this passage I would first remark, for the third time, that the natural system proposes no end, but is itself the end proposed; next I would say, that no one, except yourself, ever indulged the idea of giving the same value to a part as to the whole; that neither you nor I can possibly know *a priori* what characters are essential

sential to the use of genera, so as to deny the propriety of their being subdivided; and lastly, that so far from your power being thus destroyed when you wish to generalize, the genus remains, although possibly under another name, a groupe as much connected as before, and as much in your power for further combination, or even in a greater degree, inasmuch as by the more accurate examination of it in the process of subdivision, you must have become more definitely acquainted with its external limits, and its interior typical qualities.

Allow me here to ask two questions. First, Have you in your voluminous investigation of genera never broken up a Linnean genus? Secondly, How is it that you, who object to the combination of genera, should now complain of your power over them being destroyed when you wish to generalize?

Entomologists have to regret, that you, who in so kind and polite a manner have pointed out their defects, should not have attempted to remedy them. The only specimen which as yet you have given of the depth of your researches in this branch of Natural History, is your declaration, that Entomology is "a kingdom of Nature," and that the Linnean genus Scarabæus is an insulated groupe, which it would be the height of folly to subdivide! There is some merit in making your *debut* in a science with only two observations, and taking care that they should be both original and new. Certainly the having proposed such two solitary improvements, not only denotes your acquaintance with the subject, but well entitles you to decide that "Entomology requires the most skilful arrangement to enable the student to determine the multitude of species," and that "it is, nevertheless, unquestionably the worst furnished with assistance in this way." This may, no doubt, be *abstractedly* quite correct; but there is no one who lays down "first principles of arrangement" in Entomology, excepting yourself, who will consider it to be the height of folly to subdivide a groupe like Scarabæus, of more than 2000 known species, and, in leaving the mass in chaotic confusion, thereby think that he is giving the most skilful arrangement for enabling the student to determine them. Were you indeed to take *another* glance at two common English insects, viz. *Cetonia aurata* and *Trox sabulosus*, I should not be surprised if you changed your opinion as to the best mode of enabling the student to determine the species.

I had long thought that there was but one Natural System in the world, and that every created being formed a part of it; but you say, "Take *any* natural system, and see if there is not always a remainder of unknown things." But if the natural system be that of God, what is meant by a remainder

of unknown things? Not surely that He did not understand the relations subsisting between the things He created. And as to the Naturalists not understanding them, this only proves that we have not yet attained the knowledge of *the* natural system, and much less that of *many* of them. "We are constantly approximating to the truth, but never reaching it." At the same time it must be allowed, we are sometimes too apt to forget that the real object of the Naturalist ought to be to come as near the truth as possible, and that this is not to be done by "abstract reasoning," so much as by observing and arranging facts.

We next have a rather novel proposition started; to wit, that "the mammiferous animals are arranged with more ease, according to a natural system, (again as if there were more than one,) in consequence of their number being comparatively small, and their forms strongly marked." That is, in other words, the more widely the species are asunder, and the more distant they are in form, the more easily are they combined: just, perhaps, as a chain is more connected in proportion to the number of links that are wanting!

In order to prove that you have not confined your studies to the vegetable kingdom, you afterwards infer that the series of M. Cuvier in the *Règne Animal*, is the natural system. This author indeed says as much in his title-page; and you only think it necessary to criticize his groupes of Pachydermata and Passeres, and to prefer Jussieu's method of having for such *unknown things* a miscellaneous groupe at the end of the work. As neither *Passeres* nor *Pachydermata* are much more "unknown" than other beings, it would perhaps save trouble, and give more satisfaction, to make one miscellaneous groupe of the whole of organized matter.

You decide that "those persons, who imagine it to be necessary or advantageous to find a place for every thing, appear to lose sight of the chief object of the natural system, and to destroy its utility as an instrument of general reasoning." So then, the Natural System, or plan by which the Deity regulated the Creation, is nothing more, in your opinion, than an instrument of general reasoning towards attaining a particular object. You are constantly alluding to this object, but what it is you do not deign to state; nor do you explain how they who endeavour to find a place for every thing destroy the utility of your instrument of general reasoning. But the defect, without doubt, is on my side, and results from my being one of those practical Naturalists who would attempt to make accumulations to science without the aid of such abstract reasoning.

Your

Your reflections on the French school are, no doubt, intended, by their severity, to give us all due warning. I much question, however, whether the present perverse generation will not continue with the French to observe and arrange facts, dividing and subdividing them, rather than take with you a free and lofty range by issuing forth "first principles of arrangement" founded on abstract reasoning.

Although I am, as you are aware, no Botanist, I am glad to acquire any information on plants, and I confess your assertion, that *Parnassia* and *Linnæa* are as distinct as any of the *classes* of vegetables, is quite new to me. Still more am I interested by your observations, that "in many instances a class is equivalent to an order or genus," and that "the great division of Cotyledonous plants may only be equivalent to the Order of Grasses." I do not now wonder that in another part of your paper you should place Natural History in diametrical opposition to Mathematics, for I recollect that Euclid begins with the fundamental axiom, that "the whole must be greater than its part."

You are obliging enough to consent to the adoption of the terms *species* and *genus* in Natural History, but to these alone. All other terms for groupes are επεα πτεροεντα, "fleeting instruments of thought." But how the term *genus*, or even *species*, is not equally objectionable, how it is not equally a fleeting instrument of thought, as well as the terms Class, Order, Family, &c., I cannot well discover. In the place of these last terms you would, in the natural method, employ the words Groupe, Section, and Division; but I have yet to learn the ground of preference. Groupe is a general word for all masses of individuals, of whatever degree: and as to the words Section and Division, it surely requires explanation how they can express "assemblages of approximations" better than the terms Tribes and Families.

I have now gone through your Paper, of which, as I said at the beginning of my review, the object aimed at may, for all that I know, coincide with my own opinions. It is indeed the peculiar advantage of the style of argument you have chosen to adopt, that the purport and aim of your remarks remain enveloped in secure mystery, while the only visible points of your line of attack are detached and insulated propositions. Many of these detached propositions I am far from fighting with; many indeed are truisms; while many, such as those discussed above, will require some time, I suspect, before they can possibly triumph. But whether assented to or denied, I confess I do not perceive the use of any of them, and the novelty of but very few. Believe me, I do

not

not say this in any spirit but that of good will. I do not feel indeed, except that I happen to have followed in the wake of such idiots as Fabricius and Latreille, and have subdivided Scarabæus, that any one of your observations personally affects me; and I can never forget that you have always, in the most honourable way, been a friend to the free expression of opinion, and have of late most warmly patronized Zoology. Yet as every law-giver must, in these days, expect to have the goodness of his laws examined before they are adopted, and as it is the duty of every lover of truth to sift them well before he allows them to pass current, I have judged that you would not be displeased if I, although from a very remote quarter, should return them to you for a little amendment. You know that the days of demigods and despotism in science have for ever gone by, and that by publishing your "*principles*," you stipulated for criticism.

Your object may possibly be to clear the way for the reception of a system of your own; for I observe that you find fault both with the Linnean and Jussieuan schools of Botany, although you appear to prefer the former. I observe, also, that no system of Zoology hitherto propounded, meets with your approbation. You have, therefore, with just confidence taken a wide range for your "first principles of arrangement," and I assure you I shall be glad to hear that your talents are employed in the application of them to observed facts. You must indeed be aware that such an application of your principles will tend more to give them weight in the eyes of Naturalists than your most abstract reasoning or profound metaphysics; however to slight these last may argue the height of folly. It really, however, appears to me high time now to let every one have his own way in Natural History; and in the spirit of toleration to let the Linnean enjoy his twelve words, colons, and specific differences, while you publish your asterisk system, and the obstinate heretics continue to wallow in the mire of natural groupes and subdivisions. Persecution, I fear, only serves to wed these last unfortunate wretches to their guilt, and, moreover, is perfectly useless trouble, inasmuch as we may be sure that the world will swim in the orthodox channel at last.

I remain, dear Sir, &c.,

W. S. MacLeay.

XXX. *Note*

XXX. *Note on the Differences, either Original or consequent on Disturbance, which are observable in the Secondary Stratified Rocks.* By HENRY T. DE LA BECHE, *Esq. F.R.S. &c.**

NUMEROUS smaller variations in the mineralogical structure of the secondary stratified rocks have been long acknowledged and pointed out by many geologists. The greater or less development of a limestone or sandstone formation, the want of certain beds in a given series, the alteration of rocks within short distances from masses or veins of trap, &c., have for some time been remarked, and the greater or less importance that should be attached to these circumstances, upon the whole, fairly appreciated: but the greater changes, such as the substitution of dark compact limestones and sandstones for the green-sand of England and the North of France, though long since noticed by M. Alex. Brongniart; the transformation of the whole oolite system into compact dark-coloured limestones resembling those commonly called transition; the occasional change of all the limestones, from the chalk to those in the red sandstone formation inclusive, into dolomite, more or less crystalline according to circumstances, with other differences on the great scale,—have not generally met with that attention which the importance of the subject, in a geological point of view, seems to require.

This inattention has probably in a great measure arisen from the value attached to the different mineralogical structures which, it was supposed, characterized rocks deposited at different geological epochs. Thus all crystalline limestones were considered primitive; all dark-coloured limestones, very compact and with a certain mineralogical structure, transition; and all sandstones, when of the necessary colour and hardness, grauwacke: and when contrary opinions were advanced, there was always supposed to be some error on the part of the observer. It is true, many geologists did not admit this dependence on mineralogical structure; but it is equally true, that the greater number were in favour of it.

Geology, perhaps more than any science, requires a combination of observations; it is only from an accumulation of facts that any real progress can be made, and it is quite clear that this requires the labours of the many. Fortunately, in the present day there is no want of those who continually contribute to our stock of knowledge, more particularly in this quarter of the world; and we see that Europe, though no very large portion of the earth's surface, is fruitful in examples of great

* Communicated by the Author.

differences

differences in the mineralogical structure of the same formations. Such being the case, what still greater changes may we not expect in far distant countries?

New facts frequently lead to new opinions; and many of the latter, which were excellent in their time, and greatly tended to the advancement of geology, must be modified, should the former require it. Truth should be our only object. We search, in order to comprehend the structure of our planet's crust; but how can we expect to accomplish this, if we imagine that Geology in its infancy has attained maturity?

A change of opinions respecting the value attributable to mineralogical structure, by no means detracts from the merit of those who have been accustomed so strongly to insist on its importance. On the contrary, if districts have been well described with reference to this character,—as is, for instance, the Tarentaise by M. Brochant,—what difference does it make in the merit of such a description, whether the limestones there noticed be transition or lias, so long as we know, from a general examination of the Alps, to which formation they really should be referred? The mineralogical detail still retains its original value. Without the labours of the many excellent observers who have attached so much importance to the mineral character of formations, Geology could never have occupied the rank it now does among the sciences: these labours were as necessary to its development, as those of the present day are to clearer and more extended views. We can only reason from the facts in our possession; therefore those who come after us must have much more facility in arriving at just conclusions than we can ever expect to obtain. Werner is not the less entitled to our thanks, though his ideas respecting the formation of rocks so little accord with those now most commonly received; and he is not the less, on this account, the cause of a great advancement in the science.

The necessary limits of a note of this nature preclude any long detail. I shall therefore content myself for the present, with a few striking examples of the very great changes observable in the mineralogical structure of the oolite formation (including the lias) in the Alps and Italy, which it is hoped will be sufficient to show the very little importance of this character, when we may be desirous of determining the geological epoch of a rock, and are unassisted by organic remains*.

Those accustomed to the oolite formation, as it occurs in England

* Even when we have this assistance, it would seem safer, particularly in the case of the more modern rocks, to judge from the general nature of these remains, rather than from any particular species supposed to be characteristic.

England and France, supporting the great mass of green-sands, chalk and tertiary rocks, which constitute so large a portion of both these countries, would at first sight be little prepared to find this mass of light-coloured and often tender limestones, with their mixtures of clays or marls, connected, from some cause either original or from disturbance, into hard dark and compact limestones, resembling those commonly called transition, sometimes mixed with gypsum and dolomite; in fact, in mineralogical structure very different from the same formation in England and the North of France, where it has suffered little disturbance beyond the fractures called faults.

M. Von Buch's letter on the Dolomite of the Tyrol, is dated 1822, and his account of the Southern Tyrol, 1823. In these memoirs he states his opinion, that the dolomite mountains of that country, so remarkable for their forms and their frequent crystalline character, are probably the limestones of the country altered by the intrusion of the black or augite porphyry among them, which he supposes converted the compact limestone into a very crystalline rock, highly charged with magnesia. It would be here out of place to enter into a detail of the facts he has brought forward: I shall content myself with a reference to the map and sections, which will at least show the shattered and broken state of this part of the Alps. This Tyrolese limestone, though commonly referred to the Jura limestone, has not yet been well determined; but certainly a part at least of their continuation towards the lakes of Como, &c. is of that epoch. Those of the Tyrol are gray and shelly, and they may represent in part the chalk or green-sand series.

In 1825, M. Von Buch visited the lakes of Orta, Maggiore and Lugano, for the purpose of more particularly examining the porphyries in those districts. The result was a note on the phænomena presented by the relative position of the dolomite, limestone, and porphyries of the Lago di Lugano, which appeared first, I believe, in a German Journal, and afterwards in the *Annales des Sciences Naturelles* for February 1827. In this he took occasion to insist on the analogy observable in the phænomena of this district and those of the Tyrol, pointing out the dolomite mountain of San Salvador as an excellent example of the truth of his theory.—The following is his description.

After mentioning the red conglomerate of San Martino, con-

racteristic. We may take as an example the nummulite rocks of the Alps. These, when examined partially, have been, and no doubt will be by many observers, considered as tertiary; but if they are examined on the large scale, and their connection with other districts *carefully* examined, we can scarcely refuse to consider them as referable to the green-sand series.

taining pieces of quartz and quartziferous porphyry, he adds: "These beds dip rapidly at 70° to the S. and form a promontory in the lake (of Lugano) on which the chapel of San Martino is built. This rock appears in place for about ten minutes walk, the dip of the beds diminishing to 60°. It is then covered by a compact smoke-gray limestone, in beds about a foot thick. These dip as the beds on which they rest, and have the same inclination on the side of the mountain; but in their prolongation towards the lake, the dip continually diminishes, until at its level it is scarcely 20°. The beds, as they rise, describe a curve that somewhat resembles a parabola. The further we advance on the road, the more we find these beds traversed by small veins, the sides of which are covered by rhombs of dolomite. Similar crystals are also observable in small cavities of the rocks. As we advance, the rock appears divided into fissures, and the stratification ceases to be distinct. Lastly, where the face of the mountain becomes nearly perpendicular, it is found to be entirely formed of dolomite. There is no marked separation between the limestone and the latter rock. By the increase of the veins and geodes, the calcareous rock entirely disappears, and pure dolomite occurs in its stead." ****** "As we advance along the high road, the purer we find the dolomite, and at the same time the whiter and more granular."

"The road cut out of this mass of dolomite is not half a league long. We then observe the rocks retreat, the Monte Salvadore fall rapidly to the S., its sharp crest becoming broader, and chesnut-trees covering the side of the mountain, which previously presented a mere mass of bare rocks. From hence to beyond Melide the mountains are composed of dark augite porphyry mixed with epidote, the same as it also appears at Campione, Bissone, and Rovio."

In the highly interesting geological map which M. Von Buch has had engraved at Paris within these few days*, and which comprehends the lake of Orta, the southern parts of the Lago Maggiore, and the Lago di Lugano, he represents a small portion of mica-slate and red porphyry between the mass of

* This, like most of the other works of M. Von Buch, is intended merely for private distribution. It is to be regretted that this gentleman could not be prevailed upon to give publicity to at least a considerable portion of the mass of information, more particularly on geological subjects, which he has by so much labour and assiduity collected together. Those indeed who have the honour of M. Von Buch's acquaintance have certainly no reason to complain, for to them he is most liberal both of information and of his works; but for the progress of science generally, it is much to be lamented that such productions as the physical description of the Canaries should not be accessible to all the world.

of dolomite and augite porphyry, close to the lake, but not extending far inland. The map is one of considerable detail, and shows other masses of dolomite in contact either with the augite porphyry or the granite, which, if not changed limestone, occur at least singularly among it. There will also be observed a very great connection between the granite and porphyry, more particularly as regards their line of direction, that of the great range of the Alps. The granite is of that kind commonly known as the granite of Baveno.

Now be our opinion of M. Von Buch's theory of the formation of dolomite what it may, the fact of the passage of this gray compact stratified limestone into an unstratified crystalline rock charged with magnesia, and the presence of a large mass of augite porphyry on the side of the crystalline rock, remains still the same. With the theory that has been connected with these appearances, I have nothing now to do; my present purpose is only to show that these compact gray limestones and dolomite may both belong to the oolite formation.

Fortunately the neighbouring lakes of Como and Lecco, which I examined last May, are very instructive as regards the connection of these limestones and dolomite. If we proceed from Como by the lower lake of the same name to Bellaggio, we meet only, if we except gravels and transported blocks*, with gray compact and schistose limestones, on either side of the lake, until we reach either the side of a mountain named Croci Galle, or the opposite island of San Giovanni Battista. But if we proceed from Lecco by the lake of Lecco also to Bellaggio, the shores on both sides are formed of dolomite, if we except some gray schistose and compact limestones with anthracite at Olcio and Lierna, a few contorted beds of the same rocks opposite Abbadia, and a mass of gypsum included in the dolomite near Limonta. Now if the direction of the beds be worth any thing, part at least of the gray limestones of the Lago di Como are converted into dolomite in the Lago di Lecco, as indeed is better observed by ascending the Monte San Primo, situated between the two lakes, where looking along the line of direction of the limestone beds constituting its crest towards the lake of Como, we have limestone; towards the lake of Lecco, dolomite. Some of these limestones seem to represent the lias, for at Moltrasio and other places we find belem-

* These blocks are in great abundance in the vicinity of the Lago di Como; they occur at very great heights above the level of the lake, frequently of very considerable size; they are composed of granite, gneiss, mica slate, talcose slate, &c. &c., and may be considered as the records of the violent catastrophe which has torn them from the high Alps and carried them into their present position.

belemnites, ammonites, and other shells, among which are Ammonites Bucklandi, sometimes of very large size, A. heterophyllus, &c.

A short distance south of Bellano, the general mass of limestones and dolomite is separated from the gneiss and mica-slate of the northern part of the lake of Como by conglomerates and sandstones, the former of which closely resemble the Rothe Todte Liegende. It contains pieces of gneiss, mica slate, &c. as also pieces of the *red* quartziferous porphyry that appears on the lake of Lugano: the paste or cement often exhibits imperfect felspar crystals; and the whole, in fact, strongly reminds one of the Exeter red conglomerate, or Rothe Todte Liegende. This rock traverses the lake, to the north of a little place named La Gaeta; the line thus separating the gneiss and mica slates from the dolomite and limestone, gives that of the general direction of the two latter; and it might be supposed that the limestones and dolomite on each side would correspond, as do the gneiss and mica slates on the N.: this, however, is not the case; for if from Bellano we follow the eastern shores of the lake of Como back to Bellaggio, we have a very different section from that obtained by passing along from La Gaeta to the same place by the western coast. To the red conglomerate near Bellano succeeds dolomite for a short distance, and afterwards compact gray limestones to Varenna, near which are the celebrated black marble quarries: hence to the Fiume del Latto there is a continuation of the same limestones, in thinner beds, with schist containing anthracite, crowned near the cavern (out of which rushes the river high up the side of the mountain at the latter place) by dolomite, gradually descending to the level of the lake opposite Bellaggio. This section is then principally of gray compact limestone; while the whole of the section on the other side is dolomite, if we except the mass of gypsum included in it at Nobiallo, and a few beds of gray limestone south of Menaggio: there is therefore no correspondence between them, notwithstanding the general direction of the rocks as shown by the red conglomerates, gneiss, and mica slates, which do correspond.

The limestones and dolomite, when stratification can be seen in the latter, are highly disturbed and contorted; and igneous rocks which seem to have caused these appearances have pierced through them at the lake of Lugano.

If there be more limestones than one on the lake of Como, it is difficult to trace them; lias at least forms a part, quite different, mineralogically, from what it appears in England: probably a considerable portion of these limestones may eventually be found to represent the oolite formation generally.

In

In a note on the geological position of the fossil plants and belemnites found at Petit Cœur near Moutiérs on the Tarentaise*, published in 1828, M. Elie de Beaumont observes, that the system of beds described by M. Brochant in his memoir on the Tarentaise, and which in many places contains considerable masses of granular limestone and micaceous quartz rock, as well as large masses of gypsum, belongs to the oolite formation. He founds this opinion on the circumstance, that the most ancient secondary rocks of that country, in which no fossils have been found that have not been also discovered in the lower part of the oolite system, can be traced to the environs of Digne and Sisteron (department of the Basses Alpes), where they afford a great abundance of those fossils supposed to be characteristic of the lias.

In a notice on the geological position of the fossil plants and graphite found at the Col du Chardonet† (department of the Hautes Alpes), published in 1828, the same gentleman remarks, that as the traveller quitting the Bourg d'Oisans (Piedmont) approaches the continuous range of primitive masses that extend from Monte Rosa towards the mountains on the west of Coni, he perceives that the secondary rocks gradually lose their original character, though certain distinguishing marks may still be traced, thus resembling a half-burnt piece of wood in which the ligneous fibres may be traced far beyond the part that remains wood, into that converted into charcoal.

The quartz rocks of these countries appear to M. Elie de Beaumont to be an alteration of the anthracite sandstones, the variegated green and reddish schists that accompany them, a change from the schistose clay, and the gypsum a substitution for the limestone.

He has also remarked the original difference that exists between these secondary rocks of the interior of the Alps, and the same formations of other countries; and thence concludes that very little importance should be attached to the difference of mineralogical structure which exists between the beds above noticed, and that of the lower portions of the oolite formation, occurring undisturbed in other parts of Europe, of which these Alpine rocks appear to him the enlarged prolongation.

Without entering into the subject of all the changes which M. Elie de Beaumont considers he can trace even in the range of the Alps itself, it is enough for my present purpose that fossils characteristic of the lias are found in rocks which bear no mineralogical resemblance to it, as seen in England. On the contrary, we there find the mineralogical structure which was

* *Annales des Sciences Naturelles*, tom. xiv. p. 113.

† *Ibid.* tom. xv. p. 353.

 once

once considered as characteristic of the rocks commonly called transition.

After having examined the environs of Nice in the winter of 1827—1828, I presented an account of the geology of that neighbourhood to the Geological Society, which it appears by their Proceedings was read in November last. In it I described the two great secondary formations that occur near Nice: first, a marly arenaceous limestone, which, though unlike the green-sand mineralogically, is nevertheless the equivalent of that formation, and contains its characteristic fossils; and secondly, a rock which, though it contains both crystalline dolomite and gypsum, I referred to the Jura limestone, in consequence of its *mineralogical* structure so closely resembling the light-coloured compact limestones of that formation. I also took occasion to insist on the little value that could be attached to the presence of either gypsum or dolomite, and cited instances of their appearance in many formations. It appears by the Proceedings of the Geological Society as published in the Phil. Mag. and Annals for May last, that Dr. Buckland has read an Appendix to this memoir, containing an account of his journey by the high road from Nice towards the Col de Tende, in which he considers the inferior Nice limestones as his older alpine limestone, a supposed equivalent of the zechstein formation of Germany, in which a modification of limestone named rauchwacke constitutes one of the smaller divisions, and has been considered, erroneously in my opinion, characteristic of it*. This rauchwacke, however, does not occur in the immediate vicinity of Nice; and as there is no zoological evidence produced, I presume that the presence of the gypsum and dolomite is considered sufficient for referring the inferior Nice limestone to the zechstein. In my opinion there is but one limestone in the immediate vicinity of Nice beneath the green-sand, the almost constant mineralogical appearance of which is light-coloured and compact; it *contains* the gypsum, as is seen not far N. from the Col de Villefranche, and the dolomite is mixed with it in all ways, even the same range of beds appearing dolomitic in one place and limestone in another. It would appear therefore that Dr. Buckland's objection rests upon its mixture with the gypsum and dolomite.

* That it is by no means safe to judge of the relative ages of rocks by this modification of limestone, a formation near La Spezia is no bad example. The most modern rock in the whole gulf, apparently tertiary, is a fair mineralogical rauchwacke, sometimes occurring as the cement to a conglomerate of pieces of all the rocks in the vicinity, such as is not uncommon on the shores of the Mediterranean, and sometimes in a few beds by itself.

That

That dolomite is not characteristic of formations, even supposing it an unchanged rock, we have now abundant proof, as is stated by Dr. Buckland and others; but I know of no more striking examples than are to be found in the neighbouring department of the Var, where M. Elie de Beaumont has found dolomite in the tertiary rocks (fresh-water limestone), dolomite in the green-sand, dolomite in the oolite formation, and dolomite in the muschelkalk; and all these rocks are there well characterized, which is so far fortunate, as it prevents mistake. From the numerous observations that have been lately made, it would appear that the theory of the peculiarly dolomitic character of the limestones of the red sandstone formation, though useful in England, the North of France, and Germany, would lead to great error in the South of France, the Alps, and many parts of Italy, where so many formations above these rocks are charged with dolomite, and its frequent accompaniment, gypsum.

M. Elie de Beaumont has by a series of observations traced the various formations of the Jura and Savoy down to within a few leagues of the high road section seen by Dr. Buckland; and it would appear from these, that the representatives of the oolite formation and green-sand continued to form the calcareous Alps to within that distance. Judging from the section as described by Dr. Buckland, it would appear to be the same as that of various parts of Dauphiny, where, fortunately, fossils enable us to form conclusions respecting the ages of the different rocks; and these would seem to place the lias as the lowest part of the series, notwithstanding the dolomite and gypsum sometimes contained in it.

The limestones connected with the red sandstone formation at Toulon, and thence towards Frejus, belong to the muschelkalk, and contain the characteristic fossils of that formation; indeed, if we are to look for other limestones in the Alps, between the lias and the red conglomerates, it is much more probable that we should find the muschelkalk than any equivalent of the zechstein formation of Germany; for the former rock is not far distant from the Alps both in Switzerland and Provençe. As yet, however, no limestone containing the muschelkalk fossils have been discovered in these mountains. It would be curious, and all new observations seem to render it more probable, if in the end no Alpine limestone should be found to exist in the Alps; that is, no equivalent to the zechstein formation of Germany, to which this name has been peculiarly applied.

But to return to the Nice limestones.—It would appear from the series of observations made by M. Elie de Beaumont, and

above

above alluded to, that these light-coloured Jura-looking limestones containing dolomite and gypsum, either belong to some development of the lower part of the green-sand formation, or to the upper part of the oolite series*. As yet, however, we have no very good zoological evidence to show to which it should be referred, but it would not appear to be any equivalent of the zechstein formation of Germany.

The only other example that I shall at present offer to the attention of the reader, is taken from the environs of La Spezia, which I examined in April last, and is fortunately very illustrative of a great mineralogical change in the oolite formation.

On the west side of the gulf of La Spezia there is a range of mountains extending along the coast nearly to Levanto, their breadth augmenting as they advance N.W. The sections afforded by various portions of these mountains are composed of the following rocks, easily observed up any of the cross valleys and along the coast from Porto Venere to Monte Rosso.

1. *Limestone Series.* (the upper rocks.) } *a.* Upper beds compact and gray, varying in intensity of tint, more or less traversed by veins of calcareous spar; here and there interstratified with schistose beds, and even argillaceous slate. The beds most commonly thick. The variety with light-brown veins, so long known by the name of Porto Venere marbles, forms part of these.

b. Dolomite; varying in appearance, not unfrequently pure and crystalline, when most so, nearly white, resembling, at a distance, statuary marble; in some places beds may be distinguished, in others stratification cannot be traced.

c. Numerous thin beds of dark-gray compact limestone.

* M. Elie de Beaumont is inclined to consider them as referable to the green-sand series. The following note shows the connection of the decided representative of the green-sand and the limestones in question.—Speaking of the rocks in the southern part of the Alps, M. Elie de Beaumont says: "I have not mentioned the small portion of rocks containing nummulites which advance from the E. of the primitive mountains of L'Oisans to within a short distance of the Monestier de Briançon. This nummulitic system is intimately connected with the white compact limestone of Nice, of Provençe, of the fountain of Vaucluse, of the summit of Mont Ventoux, of the departments of the Drome, the Isere, &c., in which are found nummulites, milliolites, hippurites, &c., as well as very beautiful oolites. This same system is connected with the fossil deposits of Brianconnet (department of the Basses Alpes), of Villard le Lans (Isere), the mountains of the Grande Chartreuse, of the Mont du Chat, of the high longitudinal valleys of the Jura, of the Perte du Rhone, of Thonne, and of the Montagne des Fis."—*Annales des Sciences Naturelles*, vol. xv. p. 380.

d. The

d. The same kind of beds alternating with light-brown schist, containing a great abundance of ammonites, belemnites, and small nodules of iron pyrites.

e. The same brown schist alternating with a few thin beds of light-coloured compact limestone.

f. Light-brown schist alternating with dark-gray thin-bedded limestones as in *d.*

2. *Brown Shale.*—This does not effervesce with acids.
3. *Variegated Beds.*—Greenish-blue and reddish argillo-calcareous rocks, more or less schistose, the calcareous matter being often very small.
4. *Brown Sandstone.*—Principally siliceous, though some of it does contain calcareous matter; is sometimes micaceous; occurs in thick, thin, and schistose beds; has sometimes been called greywacke; is one of the macignos of the Italians.
5. *Gray Silicco-calcareous Schist and Sandstone.*—For the most part contains mica; may be considered as a mixture of calcareous, siliceous, and argillaceous matter, in which sometimes one predominates, sometimes the other; when the calcareous predominates there is a gray compact limestone. The whole is much traversed by veins of calcareous spar, and even, though rarely, by veins of quartz. Contains a large *fusus* at Vernazza.

Such is the section afforded by these mountains, No. 1. being the upper most rock, and No. 5. the lowest. To give, however, a clearer idea of this series, it should be stated, that it is covered, as may be seen near La Spezia, by a micaceous siliceo-calcareous sandstone, the general colour of which is either brown or gray; it is mixed with schist, and even argillaceous shale. This is another of the rocks named macigno by the Italians. The mica is sometimes wanting.

It is not my intention here to enter into a detailed account of the environs of La Spezia, which requires the necessary plans and sections, and is moreover intended for another place; but it remains for me to show that at least a part of the above section may belong to the oolite formation, and this is done by the ammonites, which are of those species found in the lower parts of that series: indeed, as far as our knowledge respecting organic remains extends, the presence of the belemnites alone would seem to show that the limestones, notwithstanding their perfect mineralogical resemblance to what has been termed transition limestones, are of the date of the lias, or some more modern rock; for as yet we have *no well authenticated* instance of belemnites having been discovered beneath it. The change in

in the oolite formation would therefore appear to be as great here as in the Alps, and probably the cause that has effected the one produced the other.

The dolomite in this range of mountains occurs singularly in the midst of the other beds, like an enormous bed or accumulation of beds. As all the strata near it are nearly perpendicular, it might even be considered a vein, did not dolomite also occur in the same rocks on the other side of the gulf: the whole country has, however, been violently convulsed apparently by serpentine and diallage rock, which sometimes occur beneath and sometimes above the same beds, and sometimes may even be seen to cut them. In fact the diallage rock and serpentine of this part of Liguria seem to have acted precisely in the manner of trap rocks, and to have burst up through the stratified formations, after the epoch of the oolite series, and probably after that of a part of the tertiary rocks, for they also are violently disturbed.

It is hoped that the examples above given, and which might easily be multiplied, of the great mineralogical differences observable in rocks that would appear to have been formed at the same geological epoch, will be sufficient to show the importance of the subject, and induce those not inclined to assent to the theories that have been connected with part of them, at least to examine into the facts; as by so doing they may discover others, which, either coupled with those before observed, or considered by themselves, may lead to new views, and to the general progress of Geology. We cannot expect that the same rocks should be developed in the same way over the whole surface of our globe; Europe alone proves the contrary: yet although the parts of a group, like that of the oolite formation, may not be determinable, the whole as a mass may; and to facilitate the study, rocks in countries distant from each other should first be considered on the large scale, leaving the minute divisions (perhaps very useful in one part of the world, but of comparatively little value out of that part,) for examination, till after the existence of the group of which they form a part has been fairly established. It moreover happens, that in countries we may chance to visit, certain rocks may be better developed than in those where the smaller divisions have been first established, which would thus require very considerable modifications. Besides, rocks may, and do occur in one country and not in another: the muschelkalk is a case in point; its existence was long denied,—and why? merely because it had not been observed or was not developed in those countries where its existence was so denied. Now if in one

part

part of France there is a rock like the muschelkalk, not to be found in the same group in another part of the same country, what right have we to suppose that, in Europe alone, we possess every formation which has been developed on the earth's surface?

XXXI. *On a Discovery of Fossil Bones in a Marl-Pit near North Cliff. By the Rev.* WM. V. VERNON, *F.R.S. F.G.S. Pres. Y.P.S.**

I WAS informed on the 30th of July by Mr. Phillips, the keeper of the Yorkshire Museum, that he had received from a scientific friend† intelligence of a discovery of fossil bones in a marl-pit near North Cliff, accompanied by such a description of the situation in which they were found as rendered the subject worthy of the closest investigation. They were stated by the writer, who had examined the spot with great accuracy of observation, to be the bones of elephant, rhinoceros, deer, ox, horse, &c., and to have lain under diluvial chalk gravel, at a depth of from 15 to 20 feet, in a marl indented by the gravel in such a manner as to appear to have been deposited before it, and containing both land and freshwater shells, Helix and Pupa, Lymnæa, Planorbis and Cyclas; the conclusion drawn by him was, that this had been an antediluvian bog.

On the following day I visited the place, accompanied by Mr. Phillips and by Mr. Salmond, whose former researches at Kirkdale gave him an additional interest in such a discovery.

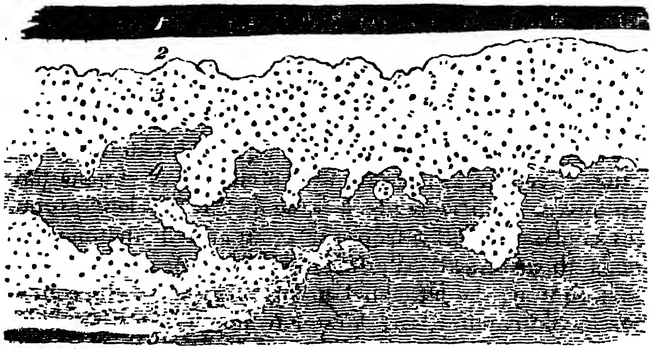
On the right of the road from Market Weighton to North Cliff, about a mile to the N.W. of the latter village there is a farm-house, marked in the large maps of Yorkshire as Biel beck house. Here we found the bones collected, and recognised the remains of all the animals enumerated above, with the addition of a large species of Felis. An account of them, as ample as the time and circumstances permitted, was drawn up by Mr. Salmond, who has allowed me to subjoin it to this paper. I need here only remark, that as far as they have been identified they are of the usual fossil species.

The marl-pit is situated near the house on a rabbit-warren, which is part of an extensive sandy plain extending westward to Holme, and southward nearly to Walling fen. Its geological position is on the eastern boundary of the red marl, where that stratum approaches the low lias hills which skirt

* Communicated by the Author.

† Wm. H. Dikes, Esq. F.G.S. Curator of the Hull Lit. and Phil. Soc.

the south-western side of the Wolds. Two hundred yards to the south the red marl appears where a few feet of gravel are removed, and it is cut into by the Market Weighton canal a mile to the west. The section which the pit displayed was thus drawn by Mr. Phillips.



		Ft.	*In.*
1.	Black sand	0	9
2.	Yellow sand	1	6
3.	White gravel consisting of small pebbles of chalk and angular fragments of flint, with a few pieces of Gryphæa incurva, and fewer pebbles of sandstone	2	6
4.	Blue marl irregularly penetrated by the gravel, No. 3, and partially chequered by it	5	0
5.	Commencement of a blacker marl.		

The lower part of the excavation was now concealed by water; but the black marl had been dug ten feet deeper: and in this the farmer, by whose intelligence the bones were preserved, informed us the greater part of them were found. The horns of the ox and the jaws of the Felis lay near the bottom of the excavation; the horn of the stag, the thigh-bone of the elephant, and one of the leg-bones of the rhinoceros, lay low in the upper marl: they occupied a space of about twenty yards in length and eight in width. The pit has been worked two years, and a single bone had been noticed in 1828; the rest were dug out during the present summer.

On examining the black marl which lay in heaps upon the ground, we found it full of shells, and of remains of decayed plants too indistinct to be made out. Many specimens of the shells were collected, and consigned to Mr. Phillips for investigation. He found them to include land, marsh, and fresh-water species; but the Lymnæa and Planorbis were most abundant, and of every size from the most minute to the full-grown

grown shell. It is not the first time that similar bones have been found with similar shells, but it is perhaps the first time that the shells have been minutely examined by so competent an observer. Mr. Phillips, after comparing the shells collected by Mr. Dikes and by ourselves, with the recent types, states, that the twelve species discovered in the marl agree in every respect, even in their accidental variations, with the same species now existing in Yorkshire.

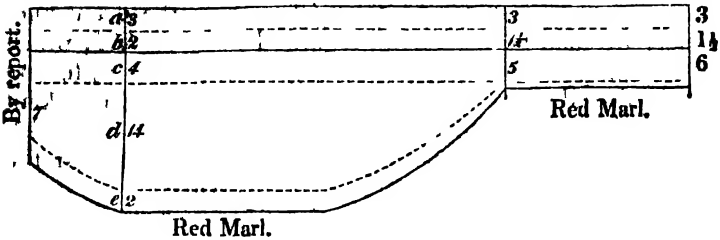
This fact has great weight in resolving the question whether the remains of elephant, rhinoceros, and lion, found in these regions under circumstances which leave no doubt that the creatures lived here, are proofs of a change of climate having taken place. There is much force in M. Cuvier's argument to the contrary, drawn from the comparative anatomy of the animals themselves. We find together a fossil elephant and a fossil glutton; the latter belonging to a genus which now inhabits a cold country, the former to one which lives in a hot climate; but the fossil elephant differs in its anatomy from the living elephant more than the fossil glutton differs from the living glutton: it is more probable then that that particular species of elephant was adapted to a cold climate, than that the glutton was fitted for a hot one. But the argument is still stronger which may be derived from the circumstance of these fossil animals being found to have coexisted with a number of molluscous species absolutely the same as those which now inhabit our country, and to have coexisted also, we may justly infer, with a number of our present plants on which those species feed. The coexistence, it may be said, requires to be proved: but I think it would be very difficult to account for the manner in which the shells and bones are here intermingled, upon any other supposition; and it must be remembered that this is not a solitary instance of their intermixture: similar shells have been several times observed to accompany the remains of elephant and rhinoceros, though the fact may not hitherto have been placed so distinctly in evidence.

But I proceed to a question of more importance, the answer to which may perhaps be allowed to determine both this point and others of superior interest. At what period did these animals live? Can we fix the epoch when the marl which envelops them was deposited?

To determine more fully the nature and direction of the deposit, I have had borings made which have furnished me with the following sections:

From North to South.

Ft. 9 Ft. 40 Yds. Ft. 20 Ft.



From East to West.

Ft. 50 Yds. Ft.

a. Sand (a pebble of quartz two inches in diameter).
b. Chalk and white flint gravel.
c. Blue marl, with some pebbles of chalk and flint.
d. Black marl, with very few pebbles of chalk and black flint, but abundance of shells, chiefly Planorbis and decayed vegetable remains, including entire seeds. Near the bottom a piece of bone.
e. Many pebbles of chalk and flint in blue marl without shells or vegetable remains.

Hence the direction of the deep deposit appears to be from east to west. About a quarter of a mile to the east, by the side of the beck, I found another marl-pit, covered with five or six feet of chalk and flint gravel*; and half a mile further in the same direction there is another, consisting of a stronger blue clay, in which much undecomposed *shale* may be perceived, enveloping in its upper part *boulders* of the chalk, blue oolite and lias of the neighbouring hills. When we consider the close proximity of these hills, in the nearest range of which (at Cliff), clay is dug from a bed of lias for the same agricultural purpose for which the marl-pits are used, we can scarcely

* It may be proper to state that I obtained from this gravel a portion of a rib which appears to me to be human, though no inference can be drawn from the fact.

doubt

doubt from whence the materials which formed those pits are derived; and when we reflect upon the low level of this country, not more than ten or twelve feet above the sea at high water, we shall be inclined to regard the present *beck*, which has of late years been deepened to drain the land, as having been quite adequate to have deposited the marl, to have kept the pond, in which the Planorbes have lived, replenished with water, and to have washed into it the land shells and the bones of the animals which frequented its banks.

The marly deposit itself, then, furnishes no precise indication of the time when these animals lived; but the gravel and sand which lie over it bear a very different character, and have undoubtedly been placed in that situation by different means. Some persons may conjecture that they have been accumulated there by high tides and ancient inundations of the Humber. I think otherwise, for the following reasons:

The white flint and chalk gravel of this district not only extends at or near the surface nine miles from hence westward along the foot of the Wolds, as far as Barmby Moor, and is of such a depth as to be worked at several points for gravel, but further to the southward and westward it passes under the great diluvial deposit of the vale of York. At Sutton upon Derwent I find it to lie under sixty-six feet of this deposit: at that place and at Elvington it contains the supply by which the wells are filled; and when it is penetrated into, the water rises more than fifty feet, and blows up a great abundance of the angular fragments of white flint. It may be traced along a line drawn from hence to North Cliff, and follows the hills eastward to Hessle on the Humber, where it is seen lying again under the above-mentioned deposit: the beds are perfectly distinct; the one consisting of chalk and chalk-flints, mingled with Gryphæa incurva, where it comes near the lias; the other consisting of the sandstones and blue limestone of the west of Yorkshire, mixed with pebbles from the slate rocks, syenite and granite of Cumberland and Westmoreland. Where it is in the form of gravel it is locally distinguished from the other by the name of the *gray* gravel; and where it consists of cobbles of mountain limestone, &c. embedded in clay, it is called by the well-sinkers the black bed. The latter is the bed which lies upon the white gravel at Sutton and at Hessle. The mighty torrent which has last deluged this great plain has left the relics of the same rocks and fossils in the cliffs of Holderness as in the gravel hills at York and at Holme.

Nor was the current which had previously covered the country under the chalk-hills with the fragments of that formation,

mation, one which had rolled less far or with less force and rapidity. At Middleton on the Wolds, upon ground of considerable height there is a vast accumulation of sand and chalk gravel worked to a depth of thirty or forty feet; in this are numerous blocks of porphyry, mixed with whinstone, lias, and sandstone; there are also pieces of cornelian and jasper, but I did not find the blue limestone or slate. Four or five miles south of this there is another deep gravel-pit, formed as I conceive by the same current after the deposition of the larger blocks; nothing is to be seen here among the chalk and flint rubble but some small pieces of sandstone and a few rounded pebbles of quartz, which are also found in the sand and gravel over the marl at Biel beck house.

Since the bones then were buried in this marl, greater floods have passed over them than any inundations of the Humber. The facts which I have mentioned show that the country has been subsequently deluged by two consecutive currents from the north, the one setting probably more from the westward than the other; I say consecutive, for there is no reason to think that they followed at distant intervals. There are in the Yorkshire Museum remains of elephant and rhinoceros from the higher diluvium. I have lately received, from the Rev. R. Cooke, the grinder of an elephant found thirty feet deep in the white gravel of Middleton; and there are now discovered teeth of the elephant and rhinoceros from a still lower deposit: but all these remains belong not only to the same genera but to the same species of animals,—species different from any which are buried in the regular strata, and different from any which now exist, yet connected with the existing animal kingdom by the shells which accompany them. This marks at least a peculiar epoch; and no account of the phænomena can be given so simple as that which supposes the flood recorded by Moses to have occasioned the general wreck, to have destroyed the most formidable species which inhabited the temperate regions of the earth, to have mingled their remains with the gravel, and to have thrown an additional covering over them when already buried in the marl.

If this be allowed, and if the facts given in this paper are correctly stated, it should seem probable that the deluge passed away without altering in any very considerable degree the condition of the earth; that the relative level of land and sea has undergone little alteration; that the climate is nearly the same, and that the species and varieties of plants and stationary animals are absolutely identical with what they were more than four thousand years ago.

Account

Account of the Fossil Bones; by Wm. Salmond, Esq. F.G.S.

The bones of quadrupeds recently discovered in a marl-pit near North Cliff appear to belong to the following animals. The dimensions are given by the French metre, with a view of facilitating the comparison of their size with the plates and measurements of Baron Cuvier's *Ossemens Fossiles.*

Elephant.—2 Teeth of the lower jaw: one almost entire, having 15 plates used, 2 unused; the other broken, having 14 plates: also 2 smaller fragments of teeth. The head of a Humerus or Femur, broken.

Rhinoceros.—2 Teeth of the upper jaw. 2 Tibiæ; the epiphyses of one wanting, the other much mutilated; the former 0·28 long. 1 Rib.

Large Quadruped.—1 Vertebra, supposed to be an Axis, the apophyses injured; the body 0·16 wide, 0·13 high.

Ox.—Occipital bone, broken; breadth over the condyles 0·15; length of the basal surface 0·15. 2 Horns, broken; one of them 0·14 in diameter at the base. 2 Vertebræ. 1 Radius, 0·40 long. 1 Metatarsal bone. 1 Astragalus. 1 Calcaneum.

Stag.—Small portions of horn.

Horse.—1 Metacarpal bone, 0·28 long. 1 Coronary, 0·85 long.

Lion.—Upper jaw, a fragment containing the two great molar teeth. Lower jaw, broken on both sides near the articulations: length from the canine to the last molar tooth inclusive, 0·14; height below the last molar, 0·05: canine tooth 0·11 long. 1 Rib, broken. 1 Radius, broken, head of 0·05 × 0·35. 1 Femur, head of. 3 Metacarpal bones, 0·15, 0·14, and 0·12 long. Several other bones supposed to belong to this animal, but broken and not identified.

The bones are in general well preserved, heavy, and seem to have lost very little of their substance, particularly those which were embedded in the lower marl. One bone shows marks of corrosion by running water, and some of them have been recently broken by the labourers at the pit; they are mostly of large dimensions. The elephant's teeth indicate an animal of nine or ten years of age. The teeth of the rhinoceros are little worn by use. The astragalus and the calcaneum of the ox correspond in size with the largest from Kirkdale in the Museum of the Yorkshire Philosophical Society. The horn exceeds in diameter those in the same Museum, but agrees with one given by Cuvier, as does the measure of the occipital condyles. The teeth of the lion are of the largest size, and extremely sharp. The feet bones exceed in magnitude those found at Kirkdale (which I consider as belonging to

to the lioness); and the other broken bones indicate a very powerful animal, the head of the radius being ⅛th longer than that of a recent lion in the York Museum.

Account of the Shells, (including those collected by Mr. Dikes,) by John Phillips, Esq. F.G.S., Keeper of the Museum of the York Philosophical Society.

The series of shells discovered in the marl consists of 12 species, all perfectly identified with living types procured in the neighbouring country, viz:

TERRESTRIAL SHELLS.

Helix nemoralis.—4 specimens marked with bands, of which the rufous colour, though faded, is still distinguishable. I observe on 3 of them, three bands on the upper whorls, and on the other, two.

Helix caperata, 2.

Pupa marginata, 3.

SWAMP SHELL.

Succinea putris, 3.

FRESH-WATER SHELLS.

Lymnæa limosa, 1.

——— palustris, 15. Varying like the recent examples in proportion and degree of smoothness, but never beveled in the upper part of the volution; the twist on the pillar lip is perhaps a little more decided and prominent. There is one specimen of a very remarkable variety, shaped like L. longiscata of Lamarck, but corrugated like the other specimens of L. palustris.

Planorbis complanatus, 23.—I can find no other difference between these and those now living near York, than the more frequent occurrence of spiral striæ across the lines of growth. The same varieties as to flatness of whorls and situation of the keel as in fresh specimens.

Planorbis vortex, 1.

——— contortus, 2.

——— nitidus.

Valvata cristata, 1.

Cyclas amnicus, 5, young and old.

The shells are all white, never compressed, not particularly tender, and very entire. It is probable that the Lymnææ and Planorbes inhabited the waters of a marsh, that the Succineæ lived on the aquatic plants, and that the dead shells of Helices were transported thither by rains and streamlets, as happens in such situations at the present time. Two seeds were found in the marl by Mr. Dikes, which appear to me to belong, the one to an Umbellate plant, the other to a Juncus.

XXXII. *Queries*

XXXII. *Queries respecting* Mr. Hall's *original Discovery of Achromatic Telescopes. By* A Correspondent.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I HAVE for several years observed in the chronological table of the original construction of astronomical instruments, published in the valuable French Almanac, entitled "*Annuaire présenté au Roi par le Bureau des Longitudes,*" that the first achromatic telescope is stated to have been constructed by Mr. Hall in 1750; and the publication of the discovery of achromatic telescopes by Mr. Dollond is dated eight years subsequently, or in 1758.—As few of our English writers on optics have ever mentioned the name of Hall, his merit, as the original inventor of the achromatic telescope, is almost unknown in the country where the discovery was first made. The discovery is indeed faintly alluded to in a note by Dr. Young in his Lectures; and a reference is made to the Philosophical Magazine for November 1798, where I find a more ample account of Mr. Hall's telescopes; but the information is still confined to a note, and very brief: it becomes, however, extremely valuable from the testimony of the late Mr. Ramsden, that it contains a true statement of the facts relating to the discovery.

The attention of astronomers is at present directed to the improvements lately made by opticians on the continent in achromatic object-glasses, which are now constructed in a perfect manner, with apertures far exceeding any that have been made from English glass, and which will probably supersede entirely the use of large reflecting telescopes. The mirrors of the latter, beside their liability to tarnish, have their figure injured by their own weight when they exceed two feet in diameter.

It will doubtless be acceptable to many of your readers to republish the few but decisive facts at present known respecting Mr. Hall's important discovery, to which I shall subjoin some queries; the answers to which would gratify the astronomers of this country, and tend to render justice to a gentleman whose merits have been unaccountably neglected. "The inventor was Chester More Hall, Esq. of More Hall, in Essex." It appears from his papers, that he commenced his labours in the year 1729; and after many experiments, he had the good fortune to find two sorts of glass which had the requisite properties for dispersing the rays of light in contrary directions when formed into lenses, in order to show objects colourless.

"About 1733 he completed several achromatic object-glasses (though he did not give them that name), which bore an aperture of 2½ inches, though the focal length did not exceed 20 inches; one of which is now in the possession of the Rev. Mr. Smith of Charlotte-street, Rathbone Place. This glass has been examined by several gentlemen of eminence and scientific abilities, and found to possess the properties of the present achromatic glasses.

"Mr. Hall used to employ working opticians to grind his lenses; at the same time he furnished them with the radii of surfaces, not only to correct the different refrangibility of the rays, but also the aberration arising from the spherical figures of lenses. Old Mr. Bass, who at that time lived in Bridewell precinct, was one of these working opticians, from whom Mr. Hall's invention seems to have been obtained.

"In the trial at Westminster Hall about the patent for making achromatic telescopes, Mr. Hall was allowed to be the inventor; but Lord Mansfield observed that 'it was not the person who locked up his invention in his scrutoire that ought to profit by a patent for such invention, but he who brought it forth for the benefit of the public.' This might perhaps be said with some degree of justice, as Mr. Hall was a gentleman of property, and did not look to any pecuniary advantage at the time from his discovery. That Mr. Ayscough, optician on Ludgate Hill, was in possession of one of Mr. Hall's telescopes in 1754, is a fact which at this time will not be disputed."

The note, of which the substance is here given from the Philosophical Magazine for November 1798, vol. ii. p. 177, is there stated to be taken from the Gentleman's Magazine for October 1790; but it derives particular interest from Mr. Tilloch's information, that the celebrated optician Mr. Ramsden confirmed the truth of the statement.

Are any of Mr. Hall's achromatic telescopes now in existence?

Is any correct information now to be obtained respecting the performance of Mr. Hall's telescopes?

Are any of Mr. Hall's papers containing the principles of his discovery extant?

Is any information to be obtained from records of the trial in Westminster Hall, respecting the original discovery of achromatic telescopes?

Is any thing further known respecting the philosophical labours or the life of Mr. Hall?

These inquiries are, I conceive, not undeserving the attention of the Astronomical Society. Florence preserves with religious

gious care the original telescopes of Galileo: the original reflecting telescope of Newton is carefully lodged in the British Museum; yet the first achromatic telescope, which displays far more ingenuity and deeper philosophical research than either, has not hitherto been deemed worthy of notice or preservation by any scientific society in the country in which the discovery was made.—Your's, &c. R. B.

P.S. The notices respecting the discovery of achromatic telescopes in the *Annuaire* are given as under:

"Hall construit une lunette achromatique......... 1750
Dollond publie la decouverte des lunettes achromatiques .... 1758."

It should appear, however, from the note above quoted, that Mr. Hall's discovery was made about the year 1733.

XXXIII. *On the Discovery of Iodine and Bromine in certain Salt Springs and Mineral Waters in England. By* CHARLES DAUBENY, M.D. *Professor of Chemistry in the University of Oxford.*

To the Editors of the Philosophical Magazine and Annals.

DR. DAUBENY, professor of Chemistry at Oxford, will feel obliged to the editors of the Philosophical Magazine and Annals, to announce among the other scientific notices in the next Number of their periodical, the discovery which he has made of iodine and bromine in several salt springs and mineral waters of this country.

He has obtained the *latter* principle in a separate state from one of the Cheshire brine springs, and has fully satisfied himself of the existence of the *former* in two or three; but as he has not yet had time to ascertain the proportions in which they occur, must content himself, for the present, with this simple announcement of the fact.

He has found iodine not only in more than one of the Cheshire salt springs, but likewise in several waters containing purgative salts, such as those of Cheltenham, Leamington, Gloucester, and Tewkesbury; whilst bromine is of still more frequent occurrence, and is perhaps entirely absent from none of the English springs which contain much common salt, except that of Droitwich in Worcestershire, although the proportion in which it exists seems to vary considerably.

Oxford, August 3, 1829.

P.S. The discovery in question was first announced at a meeting of a scientific society in this place on Friday, May 1,

 XXXIV. *In-*

XXXIV. *Intelligence and Miscellaneous Articles.*

ASPARTIC ACID AND ASPARTATES.

M. PLESSON has shown that the crystalline matters obtained from the young shoots of the asparagus, the liquorice root, and the marshmallow, are identical, and have been described under the name of *asparagine.* When treated with hydrate of lead, an insoluble saline compound is obtained, which gives *aspartic acid,* when decomposed by sulphuretted hydrogen; the properties of this acid are the following: The aqueous solution deposits a fine crystalline brilliant powder, which consists of long quadrangular prisms with dihedral summits. It is inodorous, slightly acid, and reddens litmus. Water at 47° Fahr. dissolves 1–128th part of its weight, but it is more soluble in hot water. Alcohol does not dissolve it; and its specific gravity is 1·873. Heat decomposes it, yielding ammonia and hydrocyanic acid: sulphuric acid, if hot, decomposes it, but nitric acid has very little effect upon it. It expels carbonic acid, and by long ebullition, like sulphuric and kinic acids, it converts starch into sugar.

This acid combines with most bases; the resulting aspartates are all decomposed by heat: those which have a mineral alkali base are decomposed into ammonia, hydrocyanic acid, and metallic cyanide, &c. The soluble aspartates have a remarkable flavour of meat gravy; this flavour is most pure in neutral alkaline or earthy salts; in the metallic salts it is followed by a styptic taste; and in the salts containing a vegeto-alkaline base, it is overpowered; oxygen being 8, its equivalent number is about 136.

Aspartate of potash is an uncrystallizable salt, attracts moisture from the air, has the flavour already noticed with a slight degree of sweetness; it is soluble in water, does not precipitate the muriates of barytes, lime, nickel, cobalt, gold, quina, cinchonia or morphia, corrosive sublimate, or tartar emetic.

It does not precipitate sulphate of copper or permuriate of iron; but with the former it produces a magnificent sky-blue colour, and the latter solution becomes of an intense red.

With the acetates of lead, the protonitrate of mercury, and nitrate of silver, the aspartate of potash forms a more or less abundant white precipitate, soluble in nitric acid, and also in an excess of either of the two salts.

Aspartate of soda crystallizes readily, possesses the peculiar flavour, with a saline taste. Aspartate of barytes is a friable mass, consisting of very small white opake crystals: it has the flavour of the aspartates, without bitterness. Aspartate of lime: this is a gummy mass; its taste resembles that of aspartate of soda, and is not at all like any other calcareous salt. It becomes sensibly alkaline by ebullition with carbonate of lime.

Aspartate of magnesia greatly resembles that of lime.

Aspartate of zinc crystallizes in small white opake grains, does not attract moisture from the air; possesses the peculiar aspartate flavour, which is soon followed by the stypticity of the salts of zinc.

Aspartate of nickel by slow evaporation becomes a green fragile mass.

Aspartate

Aspartate of quina is very soluble in water; that of cinchonia crystallizes very readily in fine prismatic needles, while the aspartate of morphia yields a gummy mass, in the middle of which, numerous small brilliant crystals are readily distinguishable.

All the soluble aspartates are obtainable directly, or by treating the aspartate of barytes with a proper sulphate; those which are insoluble are procured in the direct mode, or still better by double decomposition.—*Annales de Chim. et de Phys.* xl. 309.

ATOMIC WEIGHT OF IODINE AND BROMINE.

Oxygen being 100, Berzelius has determined that the weight of iodine is 789·145, and the density of its vapour 8·7011, which differs only 0·0149 from the determination of Dumas.

The atomic weight of bromine appears 489·15 and the density of its vapour 5·3933.—*Ibid.* xl. 430.

PECTIC ACID AND THE JUICE OF CARROTS.

M. Vauquelin has analysed the juice of carrots:—the following are the results of his examination.

The juice of carrots contains albumen, mixed with a resinous fatty matter and mannite.

A saccharine principle, which crystallizes with difficulty; an organic matter held in solution by the agency of the saccharine principle; malic acid. The saline residuum yielded by the decomposition of the juice, is formed of lime and potash combined with phosphoric, muriatic, and carbonic acids; the latter results from the decomposition of the organic substances.

The residuum, insoluble in cold water, contains vegetable fibre, pectic acid, or the principle which yields it, supposing it not to exist ready formed; the saline residuum yielded by combustion consists of phosphate and carbonate of lime. The saccharine matter, deprived of the insoluble principle, dissolved by its agency, is susceptible of the vinous fermentation, but loses this property by the influence of this principle, and is converted into mannite. Pectic acid when heated in a crucible with excess of potash, furnishes oxalic acid.

Common water may be employed for washing the marc of the carrots; if the carbonated are substituted for the caustic alkalies, the acid is obtained in greater plenty and purity.—*Ibid.* p. 41–46.

SCIENTIFIC BOOKS.

Just Published.

Numbers I. and II. of Mr. Strutt's *Deliciæ Sylvarum*; or, Grand and Romantic Forest Scenery in England and Scotland.

No. I. contains the following etchings: Windsor Forest; Epping Forest; Marlborough Forest; Banks of the Wye.

No. II. contains: The Linn of Dee, Forest of Bræmar; the Burnham Beeches, Buckinghamshire; Scene near Stoneleigh, Warwickshire; Cottage in the Forest of Arden.

REMARK-

REMARKABLE COLDNESS OF THE LATE SPRING.

The cold and backward spring which we have had in this country has been the subject of general remark. Our correspondent Dr. Forster, who has recently returned from a tour on the Continent, has made a corresponding remark abroad. The crops, and particularly the garden productions and flowers, have been nearly a fortnight later than usual, almost all over Germany and the northern parts of France. At Spa, the season was so cold and unpleasant that most of the visitants had left it to travel elsewhere till there were some signs of summer; and there was ice on the water near Liege, on the morning of the 8th of June. The thermometer during the day did not rise higher than 58° of Fahrenheit; and a cold dry wind seemed to threaten a total destruction of vegetation. Paris however, we understand, was comparatively warm, and the climate seemed to change for the better on passing Arras into France.

METEOROLOGICAL OBSERVATIONS FOR JULY 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·31 July 21. Wind S.W.—Min. 29·36 July 3. Wind S.W.
Range of the mercury 0·95.
Mean barometrical pressure for the month .... 29·889
Spaces described by the rising and falling of the mercury........... 6·100
Greatest variation in 24 hours 0·470.—Number of changes 21.
Therm. Max. 74° July 25. Wind S.W.—Min. 47° July 26. Wind N.E.
Range 27°.—Mean temp. of exter. air 61°·97. For 31 days with ☉ in ♋ 62·39
Max. var. in 24 hours 21°·00 -- Mean temp. of spring-water at 8 A.M. 53·15

De Luc's Whalebone Hygrometer.

Greatest humidity of the atmosphere in the evening of the 10th ... 88°
Greatest dryness of the atmosphere in the afternoon of the 27th... 42
Range of the index 46
Mean at 2 P.M. 63°·5.—Mean at 8 A.M. 67°·2.—Mean at 8 P.M. 74·6
—— of three observations each day at 8, 2, and 8 o'clock .... 68·4
Evaporation for the month 3·30 inch.
Rain in the pluviameter near the ground 5·385 inch.
Prevailing wind, S.W.

Summary of the Weather.

A clear sky, 2½; fine, with various modifications of clouds, 13; an overcast sky without rain, 7½; rain, 8.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
25	16	28	0	24	28	26

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
1	1	1½	2	4	13	6	2½	31

General Observations.—This has been a very wet month, and the coldest July here since 1823; only five days have passed without rain, and the long continued winds from over the Western Ocean have blown at intervals unusually strong at this season of the year.

In consequence of the humidity of the atmosphere, and the slow evaporation, several strata of clouds have generally prevailed, and often terminated, by the union of crossing winds, in thunder-storms, accompanied with destructive lightning in several parts of the country.

Some

Some fields of wheat were partly lodged in the neighbourhood in the middle of the month, by the heavy showers of rain and hail; but they recovered their standing during the two or three following fine sunny days. The wheat harvest is becoming general here, and there will certainly be a good average crop. The barley is much improved by the rains, and promises favourably, and beyond all expectation at the beginning of the month. Notwithstanding the continually wet weather, and the comparatively low temperature of the atmosphere, the corn and fruits, by means of intervening hot sunshine, have grown rapidly, and with the exception of wall-fruit, will yield abundant crops; so that a backward spring like the last, is not always ultimately disadvantageous to agriculturists. In the evening of the 3rd instant a very heavy gale passed over, and did much damage among the fruit-trees; but it was not felt so injurious a few miles distant. On the 5th, 14th, 16th, and 24th, distant thunder was heard here, and it lightened throughout the night of the 24th.

In the afternoon of the 14th two parhelia appeared for a short time, the one on the south side of the sun was observed to form and disappear. The nights of the 19th and 26th were cold, with N.W. and N.E. winds; and slight hoar frosts were observed in the grass fields at sunrise on the following mornings.

The atmospheric and meteoric phænomena that have come within our observations this month, are two parhelia, three solar halos, seven rainbows, thunder on four days, and lightning on one; and ten gales of wind, or days on which they have prevailed; namely, one from the North-east, one from the South-east, two from the South, and six from the South-west.

REMARKS.

London. — July 1. Stormy and wet. 2. Fine, with showers. 3. Stormy and wet: boisterous gale at night. 4. Fine morning: stormy and wet. 5. Cloudy, with heavy showers. 6. Very fine. 7. Stormy and wet. 8. Very fine. 9. Cloudy: fine afternoon. 10. Very fine: cloudy, with rain at night. 11. Rainy. 12. Cloudy, with heavy showers. 13. Drizzly: cloudy, with some thunder in the evening. 14. Rainy. 15, 16. Very fine. 17. Stormy and wet. 18. Stormy rain, with thunder and heavy shower of hail at 3 P.M. 19—23. Very fine. 24. Very fine: cloudy and sultry afternoon. 25. A violent thunder-storm at 2 A.M., accompanied with much rain and hail. It continued only for about an hour, in the course of which not less than an inch of rain fell: cloudy. 26. Cold and cloudy. 27, 28. Very fine. 29. Wet morning: showery. 30. Very fine: violent thunder-storm at 4 P.M. 31. Fine.

Penzance.—July 1. Rain. 2. Fair: showers. 3. Rain: stormy. 4—6. Fair: showers. 7. Rain: fair. 8. Fair. 9. Fair; a shower. 10, 11. Rain: fair. 12, 13. Showers. 14, 15. Fair. 16. Clear. 17. Rain. 18. Fair: showers. 19. Showers: fair. 20, 21. Clear. 22. Misty: fair. 23. Clear. 24. Fair: misty. 25. Fair. 26. Showers: fair. 27. Clear: a shower. 28. Heavy rain. 29. Clear: heavy showers. 30. Shower: clear. 31. Clear.

Boston.—July 1. Cloudy: rain A.M. 2. Fine. 3. Fine: rain and rainbow P.M. 4. Cloudy and stormy. 5. Cloudy. 6. Fine. 7. Cloudy: rain A.M. and P.M. 8—10. Fine. 11. Cloudy. 12. Fine: rain early A.M.: rain P.M. with thunder and lightning. 13. Fine: rain P.M. 14. Cloudy: rain A.M. and P.M. 15. Cloudy. 16. Fine: rain at night. 17. Fine: rain A.M. and P.M. 18. Cloudy: rain P.M. 19—24. Fine. 25. Cloudy: rain, with thunder, lightning, and wind, early A.M. At Sibsey and Brothertoft, a small distance from this place, this storm was attended with large hailstones, which did great damage to the standing corn, gardens, windows, &c. 26. Cloudy. 27. Fine. 28. Misty. 29. Rain: thunder and lightning P.M. 30. Cloudy: rain A.M. 31. Cloudy.

Meteoro-

Days of Month, 1829.	Barometer. London. Max.	Barometer. London. Min.	Barometer. Penzance. Max.	Barometer. Penzance. Min.	Barometer. Gosport. Max.	Barometer. Gosport. Min.	Barometer. Boston 8½ A.M.	Thermometer. London. Max.	Thermometer. London. Min.	Thermometer. Penzance. Max.	Thermometer. Penzance. Min.	Thermometer. Gosport. Max.	Thermometer. Gosport. Min.	Thermometer. Bost. 8½ A.M.	Wind. Lond.	Wind. Penz.	Wind. Gosp.	Wind. Bost.	Evap. Gosp.	Rain. Lond.	Rain. Penz.	Rain. Gosp.	Rain. Bost.
● July 1	29·642	29·374	29·40	29·35	29·62	29·45	29·07	64	54	65	54	63	55	63·5	S.	SE.	SE.	W.	...	0·32	0·750	0·370	...
2	29·640	29·543	29·55	29·54	29·72	29·64	28·92	69	52	64	52	66	56	62	S.	SW.	SW.	W.	...	·07	·070	·050	0·24
3	29·594	29·281	29·60	29·35	29·66	29·36	29·03	64	46	60	54	67	53	61	SW.	S.	S.	W.	0·30	·16	·380	·265	·02
4	29·574	29·493	29·60	29·55	29·65	29·60	28·91	66	46	63	52	65	53	58	SW.	W.	SW.	W.	...	·16	·505	·540	·05
5	29·751	29·556	29·75	29·65	29·82	29·70	29·00	70	50	65	53	64	55	63	NW.	W.	W.	NW.	...	·18	·580	·200	...
6	29·959	29·830	29·95	29·90	30·04	29·96	29·24	74	54	66	54	68	57	63·5	W.	W.	W.	W.	·25	...	...	·070	...
7	29·844	29·725	29·78	29·75	29·94	29·84	29·24	62	54	64	58	64	55	59	SW.	SW.	SW.	W.	...	·23	·270	·030	·04
8	29·804	29·703	29·85	29·80	29·90	29·80	29·20	72	53	66	58	70	56	61	SW.	SW.	SW.	W.	...	...	...	·010	·21
☽ 9	29·848	29·703	29·95	29·80	29·94	29·78	29·22	70	47	64	55	69	51	58	W.	N.	SW.	NW.	·35	...	·015	...	...
10	29·872	29·679	29·80	29·75	29·94	29·75	29·33	69	55	66	54	71	57	61	S.	SW.	SW.	W.	...	·09	·195	·085	...
11	29·555	29·382	29·50	29·45	29·60	29·47	29·05	69	54	65	57	74	57	62·5	S.	SW.	S.	calm	...	·41	·300	·035	...
12	29·598	29·422	29·55	29·50	29·62	29·50	28·83	71	54	67	57	70	58	64·5	S.	W.	SW.	calm	·25	·08	·085	·050	·07
13	29·792	29·604	29·65	29·60	29·86	29·68	29·10	71	61	68	57	72	62	64	SW.	SW.	SW.	SW.	...	...	·525	·010	·16
14	29·848	29·838	29·80	29·75	29·92	29·90	29·21	73	54	69	58	73	56	67·5	SW.	W.	S.	W.	...	·27	...	·145	·16
15	29·975	29·933	29·95	29·95	30·05	30·02	29·35	75	53	67	54	69	57	64·5	SW.	W.	SW.	W.	·30	·92	...	...	·50
○ 16	29·966	29·922	29·96	29·94	30·03	30·00	29·30	73	51	68	54	71	55	64	S.	W.	W.	W.	...	...	...	·230	...
17	29·912	29·550	29·65	29·63	29·94	29·68	29·32	65	57	67	55	62	59	62·5	SE.	SW.	SW.	W.	...	·46	·320	·845	·36
18	29·678	29·532	29·75	29·63	29·76	29·64	28·93	64	59	67	55	71	58	61	SW.	W.	SW.	W.	·30	·70	·210	·240	·12
19	30·065	29·783	30·05	29·85	29·99	29·83	29·21	74	48	67	57	70	50	62	W.	NW.	W.	W.	...	...	·070	·260	...
20	30·224	30·079	30·17	30·15	30·20	30·16	29·44	73	50	66	54	70	51	62·5	W.	NW.	NW.	W.	...	...	...	·030	...
21	30·220	30·125	30·20	30·20	30·31	30·30	29·62	77	56	69	55	71	58	62·5	W.	NW.	W.	NW.	·40	...	...	...	...
22	30·201	30·162	30·18	30·16	30·30	30·25	29·51	78	55	66	59	71	57	68·5	SW.	W.	SW.	NW.	...	...	...	...	...
☾ 23	30·157	30·076	30·10	30·06	30·24	30·13	29·50	77	54	71	56	68	59	67·5	NE.	E.	SE.	NW.	...	...	...	...	...
24	29·980	29·812	29·85	29·83	30·02	29·90	29·41	74	61	69	59	73	60	68·5	NE.	E.	E.	SE.	·35	1·03	...	·180	...
25	29·878	29·830	29·85	29·82	29·99	29·96	29·18	78	55	67	60	74	56	66	N.	N.	SW.	NW.	...	...	...	·580	·83
26	30·087	29·931	30·08	30·00	30·12	30·00	29·52	60	45	63	56	63	47	58	N.	E.	NE.	NE.	...	...	·100	·020	...
27	30·118	30·063	30·10	30·10	30·16	30·15	29·58	70	42	65	53	66	50	57·5	NE.	SW.	N.	E.	·40	...	·040	...	...
28	30·079	29·876	30·05	29·60	30·14	29·95	29·50	74	57	65	53	71	59	61·5	SE.	S.	S.	E.	...	...	·840	·300	...
29	29·852	29·625	29·61	29·60	29·73	29·67	29·20	70	47	63	52	70	55	61	E.	W.	SW.	E.	...	·17	·240	·330	...
● 30	29·886	29·710	30·00	29·75	29·91	29·71	29·23	72	50	63	53	66	51	68·5	NE.	N.	N.	NE.	...	·88	·120	·510	1·01
31	30·148	29·951	30·12	30·10	30·18	30·06	29·50	68	44	64	56	68	52	60·5	N.	N.	NW.	NE.	·40		...	...	0·11
Aver.	30·224	29·281	30·20	29·35	30·31	29·36	29·24	78	42	71	52	74	47	62·4					3·30	5·23	5·615	5·385	3·88

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

OCTOBER 1829.

XXXV. *Notice on the Excavation of Valleys.* By HENRY T. DE LA BECHE, *F.R.S. &c.**

[With a Plate.]

TWO opinions have been entertained by geologists, as to the causes that have excavated valleys: some contending that they have been produced by the rivers that now run in them, aided by the bursting of lakes and meteoric agents; while others consider that the greater proportion of such valleys have been formed by what has been called diluvial action, and by other causes operating at the bottom of ancient seas. It appears to me that these two rival theories may be reconciled with the facts presented by nature, and that both are, to a certain extent, correct. It would, I think, be almost impossible to deny that rivers, more particularly those discharged from the many lakes that probably once existed, have cut deeply into the land, and have formed gulleys, ravines, and gorges: but again, it seems utterly at variance with the relations of cause and effect, to suppose that valleys, properly so called, could have been formed either by the discharge of lacustrine waters, or by the rivers that now run, or could ever have run, in them.

In the discussion of this subject, we should consider only such valleys as, by the correspondence of horizontal or nearly horizontal strata on their opposite sides, show that the strata were once continuous, and that their continuity has been destroyed by the removal of the intermediate portions;—of course, the very numerous valleys formed by rents and contortions, and such as have been termed valleys of elevation and depression, as well as those of original formation, do not enter into our present consideration.

* Communicated by the Author.

It seems to me that aqueous excavations are of two kinds: 1. Those produced by vast and violent causes not now in action; and, 2. Those resulting from the continuous and gradual operation of lakes, rivers, and other agents that have been termed meteoric: the latter series of causes operating upon valleys that most frequently owe their prior existence to the former series, and both offering very distinct appearances. Excavations of the second kind, or those produced by actual streams, present cliffs, gorges, and ravines; while the first are marked by grand and extensively rounded outlines, and by valleys of a breadth and magnitude which would seem only referable to a voluminous mass of moving waters.

I shall endeavour to illustrate my opinions by the following examples.

I.—*Valleys of Excavation in Dorset and Devon.*

Valleys of the first class, which have been usually termed valleys of denudation, are very common in districts where rocks are not far removed from an horizontal position; these, to take examples from our own country, are very abundant in Dorsetshire and the east of Devon. In these valleys, the former continuity of the strata on either side is most apparent, and neither elevations nor depressions could have caused them: they are exclusively due to the excavation of the materials by which their sides were connected. The question then arises, what has excavated them? At the bottoms of each of these valleys we find a small stream, the natural drain of the land. Could these streams have cut out such valleys as they now flow through? If there be any true relation between cause and effect, they could not. Fig. 1. (Plate II.) represents a general section of the valleys of Lyme Regis and Charmouth. The summits of the hills are chiefly composed, as has already been noticed by Professor Buckland, of angular flint and chert; the remains of the former superincumbent strata of chalk and green-sand, that have been partially dissolved in place. Beneath this is green-sand, with an unequal upper surface, resulting from the causes that produced the gravel; still lower is the lias in which the spacious valleys of Lyme and Charmouth have been principally scooped out: in the bottom of each valley is a little stream, which I have necessarily represented in the section on a scale much too large. If I had confined myself strictly to proportions, it would have been invisible; yet to such insignificant streamlets, and the rain-waters which acted in conjunction with them, the advocates for the excavation of valleys by actual causes would refer the whole. The most remarkable of these valleys is that of the Char at Charmouth,

mouth, which forms the sole channel of drainage to a district many miles in length. The actual force of this stream, even with every assistance from floods and rains, has not accomplished more than a cut varying from four to fifteen feet deep, bounded by perpendicular walls: these walls composed for the most part, not of the lias strata that have been widely excavated, but of flint and chert gravel, and drifted materials such as are strewed over the valley at all heights, from the bed of the actual river to the tops of the hills. The question may be asked, why, if some solvent power has been able to produce the unrolled gravel on the summits of the hills, it has not been able to cause the valleys themselves. If these valleys in the lias had been equally covered by a *brèche en place*, composed of fragments of lias, it might be urged that they also were produced by dissolution of the lias. No such breccia has been found in them; and the only remaining adequate agent seems to be a voluminous mass of moving waters, to the duration of which I will not venture to assign a time. This seems to have acted on the rocks in proportion to their hardness and composition.

Such valleys as those of Lyme and Charmouth occur in all countries where nearly horizontal strata have not been much disturbed; and the causes that produced them seem to be the same with those that have also operated extensively upon the great escarpments of strata, leaving outliers and other marks of former continuity, which some great overwhelming force has interrupted*.

II.—*Valleys of Excavation in Jamaica which cannot be referred to Rains or Rivers.*

Depressions on the earth's surface existing when the present order of things commenced, would become channels of drainage to rain-water accumulating into streams and rivers. There are however depressions in which not even a rivulet at present flows, and of these we have examples in the white limestone districts of Jamaica, where the inhabitants are compelled to obtain water exclusively by collecting the rain in tanks; yet in these districts the natural inequalities of the land present the same forms of hill and dale as occur elsewhere; and even the violent rains in this tropical climate form no continuous rivers, but are swallowed by numerous sink-holes or natural

* This force seems to have been exerted very generally; for in all countries there are inequalities of surface, independent of stratification: and it is by no means uncommon to see the higher parts of curved and contorted strata removed, so that in sections strictly representing them, we are obliged to add imaginary dotted lines to render the curvatures intelligible to persons unaccustomed to geological investigations.

 cavities

cavities that pervade the white limestone of Jamaica. One great valley is remarkable; it is situated between the Carpenter and Santa Cruz mountains, and is excavated in a white limestone interstratified with a red sandstone. It continues inland some miles from the sea at Alligator Pond Bay. The bottom is in general an arid plain or savanna, here and there studded with insulated masses of rock bounded by broken cliffs; these rocks are covered with vegetation, and resemble, in this respect, oases in a desert. They consist of white limestone in nearly horizontal beds, varying from four to ten feet in thickness, and seem to be the remains of continuous strata, which have been nearly destroyed by some great force, but certainly not by that of the waters that now run in the valleys; for there is neither river nor rivulet throughout its whole extent. The river that rises suddenly near the sea, and flows but a short distance at the lower termination of this long and wide valley, is most probably derived, like many similar Jamaica streams, from waters swallowed by sink-holes in the interior of the island.

III.—*Valleys of Denudation subsequently cut into Ravines, and otherwise modified by existing Causes.*

As the smooth-sided valleys of denudation I have been describing form the present drain of pluvial waters, I proceed to consider what changes these waters, and the streams resulting from them, have effected in the original outline of such valleys.

These changes are often very considerable, and sometimes so modify the valleys that their features derived from denudation are nearly obliterated. When the original valley has been scooped out of soft substances, such as soft sandstone or conglomerate, a river resulting from the drainage of the land will have cut a gorge or ravine with cliffs of greater or less height on either side according to circumstances. Of this modification of a valley, the Vallon Obscur, near Nice, will afford an example; *a, a,* fig. 2. are the sides of the original valley; *b, b,* the gorge or ravine formed by the torrent that has cut through the nearly horizontal strata of tertiary sandstone and conglomerate down to its present bed. The same rocks in the same vicinity afford other examples of this modification of original valleys, so that in some cases it would be difficult to say whether they are original, or have been produced by actual meteoric causes. These conglomerates and sandstones are generally of easy disintegration, and readily give way.

IV.—*Action of Rivers in nearly level and spacious Valleys.*

Rivers when flowing through extensive and nearly level valleys seem to effect little beyond an occasional change of

bed;

bed; but when a bank, a small hill, or the foot of a mountain, opposes their progress, they assail it, and form cliffs, the materials of which, if soft, fall into the stream, or make undercliffs, which are in time removed, and the work of destruction slowly continued (fig. 4. *a*); or when the cliff thus formed is of harder materials, blocks are accumulated in a talus at its base, and the cliff is in a great measure secured from further attack (fig. 4. *b*.). There is scarcely a river of any considerable length or breadth which does not afford examples of cliffs thus produced; very frequently they overhang flat or gently sloping land, on which the river has flowed while employed in cutting the cliff. It is not a little curious to trace, in countries where rivers wind considerably, the various obstacles that have determined the course of the stream, causing it to attack and destroy the original more or less rounded forms of the bases of the hills.

V.—*Rivers escaping from Plains through Gorges.*

It is by no means uncommon to find plains of greater or less extent bounded on all sides by high land, and through which a principal river meanders, entering at one end by a valley, and passing out through a gorge at the other, augmented by tributary streams from the surrounding hills; sometimes these plains have no principal river passing through them, but only numerous small streams descending from the heights, and which uniting in the plain, pass out of it also through a gorge. In such cases the plain often presents the appearance of a drained lake, and such as all beds of existing lakes, if deprived of their waters, would assume. Fig. 5. is intended to convey a general idea of the interior of such drained lakes; *b*. representing the gorge through which the waters have passed during the gradual cutting down of the hill.

The lake of Geneva would appear once to have been much more extensive than at present, and to be only the remains of a greater lake which has been partly drained by the cutting down of the gorge at the Fort de l'Ecluse. The gorge at Narni seems to have let out the waters of a lake, the ancient bed of which now forms the plain of Terni. These examples have principal rivers now running in them: the bed of the Rhone runs through the drained part of the ancient lake, the remainder of which constitutes the existing lake of Geneva, and the Nera flows through the plain of Terni; and if the respective gorges through which the waters escape were again closed, these rivers would again form lakes on the surface of the plains *.

The

* The great fertile plain of Florence seems once to have been the bed of

The celebrated Rheingau may perhaps also be cited as an example of a gorge having drained a mass of waters behind it; for if closed, a lake would be formed over the plains of the Rhine back thence towards Basle.

These appearances are not confined to one part of the world; it is very easy to see from the descriptions of intelligent travellers, that they exist very commonly: I have myself observed examples in Jamaica. The district named St. Thomas in the Vale is a marked one: here we have low land bounded on all sides by hills which would form the banks of a lake, were not the waters let out by the gorge through which the Rio Cobre flows. Luidas Vale, in the same island, is a district surrounded on all sides by high land, and would form a lake, were not the waters, derived from heavy tropical rains, carried off by sink-holes in the low grounds. In consequence of this escape of the waters a lake cannot be formed, and therefore no discharging river, which should deliver the excess of waters over the lowest lip of the high land. This vale therefore presents no such gorge as would have resulted from the cutting power of a draining river, such as has taken place at St. Thomas in the Vale.

It is needless at present to attempt a further enumeration of these appearances; they will readily present themselves to the minds of those who have attentively examined any large district, particularly a mountainous district: but the famous gorge of the Via Mala in the Grisons is too striking an example to be omitted.

The valley of Domleschg, at the upper part of which stands Tusis, is separated from that of Schams by a lower cross range of mountain, which would bar the progress of the Rhine down the valley, and convert the valley of Schams into a lake, were it not for the opening of the Via Mala, which has been cut through the cross range.

Upon entering the gorge of the Via Mala, ancient rounded gravel will be observed to compose the upper part of the cliff and to rest upon soft gray schist. It seems not to have been formed, but to have been cut through by the causes that excavated the gorge. The same gravel forms terraces in the valley of Schams, also cut through at the upper extremity of the Via Mala. As we descend the gorge it will be observed in many places high above the river, reposing on the schist. The gorge itself is of considerable length, its general breadth from fifty to seventy yards, and its depth several hundred feet.

of a lake, the drainage of which was effected by a cut through the high land that bounds it on the west. If this outlet were closed, the waters of the Arno would again cover the plain and convert it into the bed of a lake.

The

The road that passes through it may be said to be notched and tunnelled in its sides. This place presents us with two epochs. 1. That when some great catastrophe broke away portions of the high Alps, with sufficient force to round the fragments, and lodge them above the margin of the gorge, as well as at the bottom of the ancient lake. 2. That in which the river has excavated the narrow gorge, cutting through the gravel and through the rock beneath it. Fig. 3. will afford a general idea of this celebrated spot; the height of the gorge being there represented very considerably greater than its real proportion to its length: *a*, *a*, the cross range cut through; *b*, *b*, gorge of the Via Mala, excavated by the Rhine; *c*, *c*, *c*, bed of the actual river, which has cut through the bed of the ancient lake as well as the gorge; *d*, *d*, supposed surface of the ancient lake; *g*, *g*, *g*, *g*, *g*, ancient gravel. It can I think be scarcely doubted that this gorge has been formed by the river that now rushes along it, and still continues its excavations. It has cut below the ancient bed of the lake, as may be seen where the gravel level has been destroyed and torn away at the higher extremity of the gorge.

The same violent cause which has lodged the gravel in the higher parts of the Via Mala, has also deposited an immense abundance of the same rolled fragments between Tusis and Coire, which actual causes tend constantly to destroy and carry away. The accumulation of mountain detritus produced by actual meteoric influences upon this gravel is also seen on both sides of Coire; from different ravines the torrents throw out daily upon the valley of the Rhine the disintegrated fragments of the mountains, and these have arranged themselves in the form of a talus at the bottom of each ravine upon the more ancient gravel, in the same manner that sand poured through a notch in a block of wood would arrange itself upon a table on which the block rested;—in this illustration the table represents the ancient gravel; the notch in the wood, the ravine in the mountain; and the sand, the modern detritus. This ancient gravel, between the junction of the two Rhines and Coire, is cut into cliffs and ravines, and undergoes daily diminution from actual causes. It contains large blocks and boulders, which would seem to refer the epoch of its formation to that which scattered blocks from the Alps in all directions. The gravel upon the higher part of the Via Mala is the same as here mentioned, and is probably of the great block epoch, and it must have been subsequent to this that the gorge itself was cut out, gradually draining the lake behind it.

The celebrated falls of Niagara afford an example of a river

now

now in the act of cutting a gorge, which, if time be allowed, may let out the waters of the lake above it. If this should ever be accomplished, the gorge will resemble those we have been describing, and show equally with them, that existing rivers may excavate gorges and precipitous channels, but that these excavations are entirely distinct from valleys of denudation. In all such cases as this, and in the minor effects of meteoric influence, we have gorges, ravines and gulleys, cliffs, taluses and landslips,—all tending to destroy the more or less rounded forms of anterior valleys which were excavated by a force acting generally and with enormous power; a force scarcely referable to any other cause than a voluminous mass of overwhelming waters.

P.S. I admit that considerable changes have been and continue to be effected on the earth's surface by causes actually existing. In the time of hurricanes, tropical rains effect that which an inhabitant of milder regions would scarcely credit. In Jamaica, the great hurricane of 1815 produced numerous cliffs and landslips in the mountains of St. Andrew and Port Royal. The gulleys also in this island are very numerous and deep, particularly in the great gravel plains. This gravel the torrents do not produce, but only tend to cut up and destroy; so also do the rivers which traverse it; the effect both of rivers and torrents being to make precipitous excavations not only in stratified rocks, but also in these beds of gravel, the origin of which must be referred to some more powerful, more general, and more ancient cause.

Although I consider that many gorges have been cut by the gradual discharge of lakes, and by the rivers that now flow in them, I by no means suppose that all gorges or ravines have been thus formed: many evidently were not; and of these, some have rivers now flowing through them, others contain no stream whatever. The gorge of Clifton near Bristol, through which the Avon passes, may be cited as an example of the first kind; if this were closed, the resulting lake would be drained in the direction of Nailsea, and exert no action on the rocks of Clifton. The carboniferous limestone districts of England abound in examples of the second kind; viz. of gorges entirely dry, or through which the rills now passing are much too insignificant to have caused them.

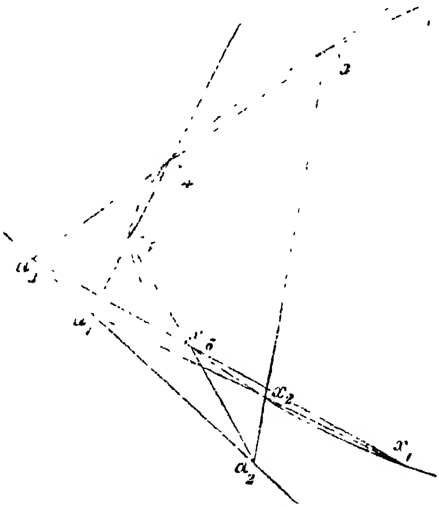
XXXVI. *On*

XXXVI. *On some Properties of Curves of the Second Order.* *By* J. W. Lubbock, *Esq. F.R.S. & L.S.**

NONE of the properties of the conic sections are more elegant than those which belong to the inscribed hexagon; and it is to be regretted that they do not find a place in elementary works on this subject. M. Brianchon has treated this question at some length in the 4th volume of the *Journal de l'Ecole Polytechnique*, and also in the *Correspondance de l'Ecole Polytechnique*, vol. i. p. 307, and vol ii. p. 383; but he seems to think that it would be next to impossible to give a direct algebraical proof of the fundamental theorem. I have endeavoured to supply this; and the proof I have given will, I think, be found quite as simple as any which have been obtained by geometrical considerations.

A geometrical proof is given by Mr. T. S. Davies, in the Philosophical Magazine for Nov. 1826.

Let $(x_1 y_1)$, $(x_2 y_2)$ $(x_3 y_3)$ $(x_4 y_4)$ $(x_5 y_5)$ $(x_6 y_6)$ be any six points in a parabola of which the equation is $y^2 = px$, the cordinate axes being inclined to each other at any given angle; and let the construction be made, which is indicated by the figure $\alpha_1 \beta_1$ being the co-ordinates of the point where the line $x_1 x_2$ produced cuts the line $x_4 x_5$. The points $(\alpha_1 \beta_1)$, $(\alpha_2 \beta_2)$ $(\alpha_3 \beta_3)$ are in the same straight line.



$\frac{x_1 - \alpha_1}{y_1 - \beta_1} = \frac{x_2 - \alpha_2}{y_2 - \beta_2}$ because by hypothesis x_1, α_1 and α_2 are in the same straight line.

* Communicated by the Author.

$$x_1 y_2 - x_2 y_1 - \alpha_1 (y_2 - y_1) - \beta_1 (x_1 - x_2) = 0$$

$y_2 y_1 - \beta_1 (y_2 + y_1) + p\,\alpha_1 = 0$; and similarly

$$y_3 y_2 - \beta_2 (y_3 + y_2) + p\,\alpha_2 = 0$$
$$y_4 y_3 - \beta_3 (y_4 + y_3) + p\,\alpha_3 = 0$$
$$y_5 y_4 - \beta_1 (y_5 - y_4) + p\,\alpha_1 = 0$$
$$y_6 y_5 - \beta_2 (y_6 + y_5) + p\,\alpha_2 = 0$$
$$y_1 y_6 - \beta_3 (y_1 + y_6) + p\,\alpha_3 = 0$$

eliminating y_1, y_3 and y_5.

$$(\beta_2 - \beta_3) y_4 y_2 - (p\,\alpha_2 - \beta_2 \beta_3) y_4 + (p\,\alpha_3 - \beta_2 \beta_3) y_2 + p\,(\alpha_2 \beta_3 - \beta_2 \alpha_3) = 0$$

$$(\beta_1 - \beta_2)\,(y_6 y_4 - (p\,\alpha_1 - \beta_1 \beta_2) y_6 + (p\,\alpha_2 - \beta_1 \beta_2) y_4 + p\,(\alpha_1 \beta_2 - \beta_1 \alpha_2) = 0$$

$$(\beta_3 - \beta_1) y_2 y_6 - (p\,\alpha_3 - \beta_1 \beta_3) y_2 + (p\,\alpha_1 - \beta_3 \beta_1) y_6 + p\,(\alpha_3 \beta_1 - \beta_3 \alpha_1) = 0$$

adding together these equations, and making for simplicity $\beta_1 = 0$, which does not affect the generality of the solution, because the coordinate axes x and y are supposed to be inclined at any given angle

$$\beta_2 y_4 (y_2 - y_6) + \beta_3 y_2 (y_6 - y_4) + \beta_2 \beta_3 (y_4 - y_2) + p\,(\alpha_2 \beta_3 - \beta_2 \alpha_3 + \alpha_1 \beta_2 - \beta_3 \alpha_1) = 0$$

and by the equations above

$$\beta_1 = \frac{y_5 y_4 - y_2 y_1}{y_5 + y_4 - y_2 - y_1} = 0, \quad \beta_2 = \frac{y_6 y_5 - y_3 y_2}{y_6 + y_5 - y_3 - y_2}, \quad \beta_3 = \frac{y_4 y_3 - y_1 y_6}{y_4 + y_3 - y_1 - y_6}$$

and substituting these values of β_2 and β_3 in the three first terms of the last equation they disappear, and we have $\alpha_2 \beta_3 - \beta_2 \alpha_3 + \alpha_1 \beta_2 - \beta_3 \alpha_1 = 0$, which equation of condition between the coordinates of the points $\alpha_1 \beta_1$, $\alpha_2 \beta_2$, $\alpha_3 \beta_3$ shows that they are in the same straight line.

The same kind of proof might be applied step by step when the equation of the conic section is more complicated, but it is simpler to extend it at once by the theory of projections.

Let the parabola ($y^2 = p\,x$, $z = D$) be the base of a cone whose vertex coincides with the origin; the equation to the cone is

$$D\,y^2 = p\,z\,x,$$

let this cone be intersected by a plane of which the equation is

$$(z - D) \sin \theta - x \cos \theta = 0.$$

θ being the angle which this plane makes with the plane $z\,y$. The equations to the curve of intersection of this plane, and the conical surface referred to axes $O z'$ and $O y'$, (O being the origin,) coinciding with the intersection of this plane and the planes $z\,x$, $z\,y$ will be found by substituting $x \cos \theta + D$ for z, and $x \sin \theta$ for x in the equation $D\,y^2 = p\,z\,x$, which substitution gives $D\,y^2 = p\,(x \cos \theta + D)\,x \sin \theta$. If this equation be identical with the equation $y^2 = p'\,x + q'\,x^2$

$$p' = p$$

$p' = p \sin \theta \quad q' = p \sin \theta \cos \theta$, and it is evident that any of the preceding equations which were true in the case of the parabola $y^2 = p x$ may be transformed so as to apply to the curve $y^2 = p x + q x^2$ by substituting for the coordinates x and y of any point in these equations

$$\frac{x \frac{p'^2}{p}}{p' + q' x}, \text{ and } \left(\frac{p' y}{p' + q' x}\right) \text{ respectively.}$$

In this way the equation

$$y_2 y_1 - \beta_1 (y_2 + y_1) + p \alpha_1 = 0 \text{ becomes}$$

$$\frac{p'^2 y_2 y_1}{(p' + q' x_2)(p' + q' x_1)} - \frac{p'^2 \beta_1}{p' + q' \alpha_1}\left(\frac{p' y_2}{p' + q' x_2} + \frac{p' y_1}{p' + q' x'_1}\right) + \frac{p'^2 \alpha_1}{p' + q' \alpha_1} = 0$$

and the final equation

$$\alpha_2 \beta_3 - \beta_2 \alpha_3 + \alpha_1 \beta_2 - \beta_3 \alpha_1 = 0 \text{ becomes}$$

$$\frac{\alpha_2 \beta_3 - \beta_2 \alpha_3}{(p' + q' \alpha_2)(p' + q' \alpha_3)} + \frac{\alpha_1 \beta_2}{(p' + q' \alpha_1)(p' + q' \alpha_2)} - \frac{\beta_3 \alpha_1}{(p' + q' \alpha_3)(p' + q' \alpha_1)} = 0$$

which gives after reductions

$\alpha_2 \beta_3 - \beta_2 \alpha_3 + \alpha_1 \beta_2 - \beta_3 \alpha_1 = 0$, which shows that the theorem is true generally of all the conic sections.

The preceding method of transformation may be applied to any problem which relates to the intersections only of lines. Thus the equation to the tangents drawn from the point (α, β) to the parabola $y^2 = p x$, the point (α, β) being without the curve is $\quad p (x - \alpha)^2 - 4 (\beta x - \alpha y)(y - \beta) = 0$;
therefore the equation to the tangents drawn from the point (α, β) to the curve $y^2 = p x + q x^2$ is

$$\left\{\frac{x p^2}{p + q x} - \frac{\alpha p^2}{p + q \alpha}\right\}^2 - 4 \left\{\frac{p^2 (\beta x - \alpha y)}{(p + q x)(p + q \alpha)}\right\}\left\{\frac{p y}{p + q x} - \frac{p \beta}{p + q \alpha}\right\} = 0$$

or, $\quad p^2 (x - \alpha)^2 - 4 (\beta x - \alpha y) \{p (y - \beta) - q (\beta x - \alpha y)\} = 0$

The property of the inscribed hexagon which has been proved leads to many very elegant geometrical constructions; amongst others it furnishes the simplest method of finding any number of points in a curve of the second order when five are given. It is probably identical with that of Pascal's mystic hexagon, upon which he founded a theory of conic sections published in 1640: unfortunately no copy of this work is known to exist.

The theorem in question is deduced by Carnot, from the following very elegant property of curves of the second order. If tangents A B, A C be drawn to any points B and C in any curve of the second order, if B and C be joined, and any line P M q r be drawn in any given direction, cutting the chords B C in P the curve in M, and the tangents produced in q and r, $\text{P M}^2 = \text{A} . \text{M} q . \text{M} r$, A being a constant quantity.—See Carnot's *Géométrie de Position*, p. 446.

Let $y^2 = px + qx^2$ be the equation to any conic section, the coordinate axes including any angle, but being such that the axis y coincides in direction with the line P M q r. The equation to the tangents A B, A C drawn from the point A, (α, β) is

$$p^2(x-\alpha)^2 - 4(\beta x - \alpha y)\{p(y-\beta) - q(\beta x - \alpha y)\} = 0$$

and the equation to the chord B C is

$$x(p + 2q\alpha) - 2\beta y + \alpha p = 0$$

If these equations be transferred to the origin M, by putting $x + x'$ for x and $y + y'$ for y, x' and y' being the coordinates of the point M, M q and M r will be the roots of the first equation, considering y as the unknown quantity, when x is made $= 0$, similarly M P is the value of y in the second equation when x is made $= 0$; therefore since by the theory of equations the product of the roots of y is equal to that part of the equation which is independent of y,

$$\mathrm{M}q \times \mathrm{M}r = \frac{p^2(x'-\alpha)^2 - 4(\beta x' - \alpha y')\{p(y'-\beta) - q(\beta x' - \alpha y')\}}{4(p\alpha + q\alpha^2)}$$

$$\mathrm{M\,P}^2 = \left\{\frac{(p + 2q\alpha)\,x' + \alpha p - 2\beta y'}{2\beta}\right\}^2$$

and since $y'^2 = px' + qx'^2$, the truth of the equation

$\mathrm{M\,P}^2 = \left\{\frac{p\alpha + q\alpha^2}{\beta^2}\right\} \mathrm{M}q \times \mathrm{M}r$ is easily recognized.

This theorem may be extended to curve surfaces of the second order.

If $\alpha\,\beta\,\gamma$ are the coordinates of the vertex of the conical surface which circumscribes the curve surface of which the equation is

$n^2p^2x^2 + m^2p^2y^2 + m^2n^2z^2 = m^2n^2p^2$ the equation to the plane of contact is

$$n^2p^2\alpha x + m^2p^2\beta y + n^2m^2\gamma z = m^2n^2p^2$$

if P M q r be any straight line parallel to the axis y cutting the curve surface in M the circumscribing cone, of which the equation is

$$\begin{aligned}(n^2p^2 - p^2\beta^2 - n^2\gamma^2)(x-\alpha)^2 + (m^2p^2 - m^2\gamma^2 - p^2\alpha^2)(y-\beta)^2 \\ + (m^2n^2 - m^2\alpha^2 - n^2\beta^2)(z-\gamma)^2 + 2p^2\alpha\beta(x-\alpha)(y-\beta) \\ + 2m^2\beta\gamma(z-\gamma)(y-\beta) + 2n^2\alpha\gamma(z-\gamma)(x-\alpha) = 0,\end{aligned}$$

in q and r and the plane of contact in P

$$\mathrm{P\,M}^2 = n^2\left(\frac{m^2p^2 - p^2\alpha^2 - m^2\gamma^2}{m^2p^2\beta^2}\right) \times \mathrm{M}q \times \mathrm{M}r.$$

$n^2\left(\frac{m^2p^2 - p^2\alpha^2 - m^2\gamma^2}{m^2p^2\beta^2}\right)$ is evidently independent of $x\,y\,z$, that is, of the position of the point M.

XXXVII. *On*

XXXVII. *On the supposed Identity of Whitebait and Shad.* By WILLIAM YARRELL, *Esq. F.L.S.**

THAT the diminutive fishes called Whitebait are the young of the Shad (*Clupea alosa*) is a point so long considered to be settled, that I fear I shall be thought guilty of a crime little short of treason in Natural History by declaring for an opposite opinion; but having devoted considerable time and attention to this subject during the present season, I shall proceed to detail the facts, historical as well as anatomical, of which this investigation has placed me in possession, and which have led me to adopt a conclusion at variance with all the English authors on this point.

Mr. Pennant in his British Zoology gives the Whitebait a place as an appendage to the Bleak (*Cyprinus alburnus*), rather, as he remarks, "than form a distinct article of a fish which it it impossible to class with certainty."

The editor of the edition published in 1812 says, "Mr. Pennant was either deceived in the specimens sent him as Whitebait, or the branchiostegous rays were injured; since he counted only three (genus *Cyprinus*) instead of eight (genus *Clupea*) of these rays, which number they certainly possess."

Dr. Shaw in his General Zoology follows Pennant, and describes the Whitebait as a species of the Carp or *Cyprinus* genus.

Dr. Turton in his British Fauna, attached to his description of the Bleak, *Cyprinus alburnus*, has the following observation: "The Whitebait which has hitherto been considered as a variety of this fish, appears by the judicious and accurate investigation of the author of the Natural History of British Fishes, to be merely the young fry of the *Clupea alosa* or Shad."

Mr. Donovan, in his Natural History of British Fishes, treats this subject at some length, and considers that his examination affords incontrovertible evidence that the Whitebait is really the fry of the common Shad.

Dr. Fleming, in his recently published History of British Animals, follows Mr. Donovan in considering the Whitebait as the fry of the Shad.

To place this subject, upon which such different opinions have been entertained, in a clear point of view, it may be proper to commence with a short account of the habits of each of these two fishes.

All English writers agree that the Shads enter our rivers in the month of May, for the purpose of depositing their spawn, and, this object accomplished, they return to sea by the end of July. They appear during these three months in the greatest

* From the Zoological Journal, vol. iv. p. 137.

abundance

abundance in the Thames, from the first point of land beyond Greenwich, opposite the Isle of Dogs, to the distance of a mile below, and immense quantities are taken every year. Formerly, great quantities of Shads were caught by fishermen at that part of the Thames opposite the present Penitentiary, but the state of the water has driven the fish higher up the stream, and the fishing for them at this point has been almost abandoned.

Very considerable numbers of Shads were also taken in former seasons as high up the river as Hammersmith, but the deterioration which the quality of the water has suffered from various causes, has rendered the fishing for Shads in this part of the river an employment scarcely worth following: the quantity of fishes obtained in a season twenty years ago, compared with the produce of the present year, would be in the proportion of an hundred to one.

By various acts of Parliament*, the conservation of the river Thames from Staines Bridge downwards, and of the waters of the Medway, is vested in the Lord Mayor and his Court for the time being, who, with the addition of certain other officers, make and enforce the execution of their own bye-laws for the preservation of the fishery. Their 23rd rule and order is as follows: "Shads shall be only taken from the 10th day of May to the 30th of June in every year."

By making an arrangement both at Putney and Greenwich, I was constantly supplied with Shads twice in every week during the whole, and even somewhat beyond the time they are allowed to be taken; and without going into a detail of weekly observations, it will be sufficient for the purpose to state, that not a single male or female Shad, examined during the months of May or June, had cast its milt or eggs, and this fact it is necessary to bear in mind. Two fishes examined on the 5th of July still retained their roes, but two others subjected to the same test on the 7th had passed their ova.

It is the opinion of the fishermen, who have the best opportunities for observation, that these adult fishes, having performed the office for which they visit the fresh water, take the centre of the current and return to sea. From their weak state, they may be said to drift, rather than swim, with the tide, and, as fishing against the stream is prohibited, they in this way proceed in safety to their destination.

Of the young Shad, when vivification of the deposited ova has taken place, but few examples are caught, and these only by the unlawful mode of fishing for Whitebait. Like the young of Salmon, and the fry of other salt-water fishes, instinct directs the exertion of their first efforts towards gaining the sea.

* 13 Edward I. c. 47. 17 Richard II. c. 9.: and 10 Anne.

The

The reason given by the fishermen why these young fishes are not caught in greater quantities, is, that immediately on their acquiring sufficient power of motion, they take the middle of the stream, and make for sea; and as no nets capable of stopping them are used in that part of the river, they escape until their return the next year as adult Shad.

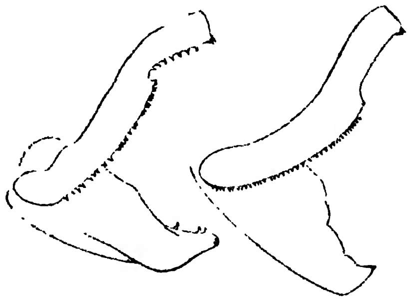
When the preceding winter has been mild, the Whitebait make their appearance early in spring. In the present year, I first observed them in a fishmonger's shop at the west-end of the town, on Saturday the 29th of March. Knowing the habits of the Shads, and that they did not make their appearance in the Thames till May, it was this early exhibition of Whitebait which induced me to take up, and persevere in, an investigation, which I have pursued to the present time. I am aware it may be urged, that the periodical visits of fishes as well as other animals are influenced and varied by the temperature of particular seasons and the condition of the animal, but as all the comparative observations I shall make on this subject will be confined to the fish of the same river, and during the same season, this objection will not be valid. Whitebait continued to be procured in the month of April; more abundantly throughout May as the weather became warmer; and with the exception of occasional interruptions to the fishing, from the activity of the Water Bailiff and his deputies, the taverns at Greenwich and Blackwall, as well as several fishmongers in London, have continued to receive a supply up to the present time. The same arrangement that produced me the Shads, produced me also constant supplies of small quantities of Whitebait for weekly examination, and the additional fee which I had promised the fishermen for every young Shad that was preserved for me, produced me, as I have reason to believe, every young fish of that species, as well as any portion I pleased of other fishes, neither Whitebait nor Shads, which the parties I engaged with caught in the pursuit of their avocation. The number of young Shads however did not exceed a score, nor did I obtain one till the end of June, recogniseable instantly from the Whitebait, and both species distinctly known to the fishermen. I may here also add, that no Whitebait are found in other rivers frequented by the Shad; not a single example of Whitebait is ever taken between Putney and Hammersmith, where the Shads deposit their spawn; and although Shads abound in the Severn, which affords this fish in higher perfection than any other river, particularly near Gloucester where immense quantities are taken, the Whitebait are unknown; nor do I ever remember to have seen a notice of the appearance of this fish in any other river in England except the Thames.

But

But it is not alone on such data as these, however conclusive they may appear, that I rely, for the distinction for which I contend. The best zoologists of the last fifty years have taught us the value as well as the necessity of searching for, and resorting to anatomical distinctions, as the best foundation for the separation of species, and I shall therefore proceed to detail the various differences that present themselves on a close examination of the external and internal characters of the Whitebait and Shad, premising, that in every instance I refer to the parts as they appear in a fish of each sort, corresponding exactly in size.

The tongue of the Shad is smooth and dark in colour, the lower jaw has three strong teeth, the whole edge of the upper jaw, which from its shape forms two distinct portions, is also armed with strong teeth, the snout bifid, the eye small.

The tongue in the Whitebait is rough and white, the lower jaw has no teeth on the outer edge, and differs in its form from the same part in the Shad; the upper jaw in the Whitebait possesses teeth on the lower portion only, the snout is not notched, the eye one third larger than that of the Shad, and there is also an appreciable difference in the form of the operculum. Its dorsal line is less curved.



Edge of the mouth of the Shad, magnified. Edge of the mouth of the Whitebait, magnified.

The dorsal fin of the Shad is placed nearer the head than in the Whitebait, and differs also in being less triangular in its form. The ventral fins of both are placed in a line immediately under that of the back. There are also differences in the number of fin rays as the following comparative statement will show.

Whitebait.

D. 17., P. 15., V. 7., A. 15. Tail 20.

Shad, according to Donovan.

D. 20., P. 19., V. 12., A. 21. Tail 26.

But I place less confidence on these variations in the number of the fin rays, as characters, than on others, not finding them

them invariably uniform. The body of the Shad is much deeper in proportion to its length than the Whitebait, its prevailing colour on the back, blue, without any very apparent lateral line. The colour of the back of the Whitebait is greenish ash, the lateral line impressed, distinct and straight. The serrations on the abdominal edge also differ in shape, as a reference to the accompanying magnified representations will de-

Abdominal serrated edge of the Shad. Abdominal serrated edge of the Whitebait.

monstrate. The form of the stomach is similar in both these fishes, as might be expected from their belonging to the same genus, but the cæcal appendages are much more numerous in the Shad than in the Whitebait. The parietes of the abdomen in the Shad are lined with a delicate silver-coloured membrane which also exists in the Whitebait, but in the latter fish this membrane is covered on the side next the viscera with a dark colouring matter resembling the *nigrum pigmentum*, not a vestige of which appears in the Shad.

There is also another difference between the Shad and the Whitebait upon which I place greater reliance, in proof of specific distinction, than on any other single anatomical character. The number of vertebræ in the Shad, of whatever size the specimen may be, is invariably 55; the number in the Whitebait is uniformly 56, and even in a fish of two inches, with the assistance of a lens, this exact number may be distinctly made out.

The value of this character as a specific distinction may be presumed by the following quotation from Dr. Fleming's excellent work on the Philosophy of Zoology, vol. ii. p. 311.

"The number of the bones of the vertebral column in different species of fishes, being exceedingly various, suggested to Artedi the use of this character in the separation of nearly allied species. Among the species of the genus *Cyprinus*, for example, a difference in the number of vertebræ has been observed to the amount of 14. In ascertaining this character Artedi recommends the greatest circumspection. The fish should be boiled, the fleshy parts separated, and the vertebræ detached from one another, and these counted two or three times in succession to prevent mistakes. This character is of great use, as it is not liable to variation, individuals of the same species exhibiting the same number of vertebræ in all the stages of their growth."

From the observations made by Mr. Donovan in his History

of British Fishes, it would be inferred, that the Shads visiting the Thames in the months of May and June, and appearing in immense quantities, heavy in roe, about Greenwich and Blackwall, there deposit their ova, which on vivification become the well-known Whitebait. It seems not to be generally known that the Whitebait, though often caught as high up the river as Blackwall, are as frequently taken as low down the river as Erith.

The situation they are found in by the fishermen depends entirely on the state of the water. Always occupying a station which affords a mixture of the water of the sea and river, they are a salt-water fish rather than otherwise, coming upwards with the first part of every flood-tide, swimming always near the surface, avoiding the strong current, preferring the slack water at the sides of the stream that they may not be carried too far up, and returning towards the sea with the first of the ebb-tide.

The net used by the fishermen for the taking of Whitebait is illegal on more accounts than one; the mode of fishing, which is against the stream, is also illegal; the fish float with the tide, and only about two hours of each ebb and flow can be employed to advantage. The fish are most plentiful when the weather is warm, and can only be taken during day-light. It would probably be difficult to ascertain the fact, but I have reason to believe that the ova which produce these swarms are deposited in shallow water on the flat shores about and below Gravesend, as I have almost uniformly received the smallest Whitebait from the lower part of the river.

The evidence printed in the Report from the commissioners appointed to inquire into the state of the supply of water to this city, contains a sentence in point on this subject, communicated by Mr. Goldham, the clerk of the fish-market at Billingsgate, a gentleman who has made fish and fisheries his particular study.

"Whitebait are certainly obtained in greater abundance than formerly, by poachers (viz. fishermen who have been thrown out of their former employ) using unlawful nets: it should however be observed, that Whitebait are taken at particular times of the tide; as they are a salt-water fish, and come and retire with the water, which is partially salt; on this account they are never known above Blackwall." See Report, page 72.

From the train of circumstances here detailed, it will be obvious that I consider the Whitebait as distinct from the Shad. I have now before me, preserved in a weak mixture of alcohol and distilled water, both young and old Shads, and nearly one hundred specimens of Whitebait of all sizes, the latter from

1 inch

1 inch in length to 4½; all taken this season, and all, as I believe, young fish of this year. By this it will be evident that their size has been much under-rated by those authors who have described the length as not exceeding 2 inches. I have also before me a fine specimen of 4¾ inches in length, an adult fish with roe, and as the fishing for Whitebait will probably continue till October, I have little doubt of obtaining others in a more advanced state as the season proceeds. I believe that these fishes deposit their spawn during the winter, that the young are slow in their first development, as well as in their subsequent growth, and probably never attain any considerable size. The food found in their stomachs most distinguishable, consisted of very minute shrimps.

To show that my expectations of obtaining other adult specimens of Whitebait with roe as the winter approaches, have some foundation, I quote from Mr. Pennant's editor the following sentence, "the accurate Duhamel asserts that the *Franc Blanquet* (of the identity of which with the Whitebait we entertain little doubt) is full of eggs and milt in November and December."

The slow development of the ova of fishes which spawn in winter may principally be referred to temperature. From the spawn of Salmon, deposited in December and January, the young fry do not come forth till March and April, while the ova of some other species, deposited in the midst of summer, become living fishes on the ninth day.

Believing that the more closely this subject is examined, the more evident the true distinction between the Whitebait and Shad will appear, I venture to propose the term *alba* for the former species, the characters of which have been already noticed in detail*. The name given by Mr. Donovan to his Whitebait (*Clupea alosa junior*) may still be retained without inconvenience, since the fishes represented by that gentleman in his 98th plate, are in reality young Shads, and not Whitebait; and I have entered thus fully into the investigation with the hope of clearing up the confusion and errors at present existing on this subject, in most of, if not all, our Zoological works.

Ryder-street, St. James's, August 1828.

Additions to the foregoing Remarks†.

The season for Whitebait fishing having expired soon after the sending my former remarks on that subject for insertion in the 14th Number of the Zoological Journal, I waited with some anxiety for the period when nets of small meshes might legally be worked at the mouth of the Thames for Smelts

* A correct figure by Mr. James Sowerby is given in the Zoological Journal.

† From the Zoological Journal, vol. iv. p. 465.

 and

and Sprats, in the hope of obtaining further evidence of the distinction between Whitebait and Shads; and in this expectation I was not disappointed. I obtained, but in small numbers only, both adult Whitebait in roe, and some young ones; but it appeared that the large shoals of this fish, like all those which visit the fresh water for the purpose of depositing their spawn, had, with their fry of the year, quitted the river and returned to the deep. As late as the month of November I obtained several small Shads, only 2½ inches in length, which illustrated another point in the history of that fish. We are told by Baron Cuvier and M. Valenciennes, in the second volume of their work on the Natural History of Fishes (p. 25), that a Perch of 7 inches is in his third year; and I therefore felt convinced that these young Shads, only 2½ inches in length when taken in November, were in reality young fishes of the same year, and that the young Shads of 4 inches in length, obtained in the months of July and August preceding, were the young fishes of the year before, the greater part of them having arrived at the length of 4 inches at or very soon after the time the adult fishes had shed their ova. There was also this obvious and invariable distinction between young Shads and Whitebait: the latter never exhibited any trace of the spots on the sides, so conspicuous in the Shads. The Shads, on the contrary, were never without some indication of these peculiar spots, though their number and intensity of colour appeared to depend on the strength and condition of the fish. The first spot immediately behind the operculum however is never wanting; some of the young Shads taken in July and August exhibited as many as five spots, but the youngest as well as the weakest invariably possess one spot behind the upper part of the edge of the operculum; even the young Shads of 2½ inches only, taken in November, the smallest I have been able to procure, have this distinction, and in this state most resemble Whitebait; but I may add in conclusion, as an invariable point of distinction between the two fishes, that I have never seen a Whitebait of any age or size with this spot, or a Shad without it.

On showing a series of specimens of these two fishes to M. Valenciennes during his late visit to London, that gentleman, who has made this branch of Natural History his particular study, stated that he considered them decidedly different.

In proposing the term *alba* as a specific distinction for the Whitebait, in a former paper, I by no means intended to be understood as supposing that this fish had remained as yet undescribed by continental naturalists, I only desired to claim for this distinct species an appropriate appellation in our list of British

British Fishes. It may be "Le Prêtre ou Spret de Calais, le Franc-Blaquet ou Franche Blanche," four names given by Duhamel to one small species of *Clupea*, though his figure is not like our fish; yet as the Whitebait frequents the Thames every summer, it is not unlikely that it should be taken at Calais.

Sir Everard Home, in his recently published additional volumes on Comparative Anatomy (vol. v. c. 4. sect. 1. page 232, and vol. vi. plate 28) has inferred, from certain resemblances in the ova and serrated abdominal edges of four fishes of the genus *Clupea*, that the Whitebait is a young Shad, and the Sprat a young Herring. Dr. Fleming in his History of British Animals, published in 1828, does not allow the Sprat a place among his fishes; and at page 183, after giving the specific characters of the Pilchard (*Clupea Pilcardus*), the following sentences occur: "The fry of the Herring and Pilchard are confounded together under the epithet *Sprat*. The position of the dorsal fin, in reference to gravity, furnishes, however, an obvious mark of distinction." The differences already detailed as existing in the anatomy and habits of Whitebait and Shads render any further observations on that subject unnecessary, while between the Sprat and Herring the distinctions are still more decided. On comparing a Sprat with a young Herring of the same length, at which age they are called by the fishermen Yawlings, the Sprat will be found to be considerably deeper, and the scales much larger; in this latter circumstance the Sprat resembles the Pilchard, but the Pilchard on the other hand is not so deep a fish as the Herring. The Sprat and Herring differ also in the number of rays in three of their fins out of the four they possess, and also in the tail, as the following numbers exhibit.

	D.	P.	V.	A.	C.
Sprat......	17	15	7	18	19
Herring...	17	14	9	14	20

There is also one other most material difference, the vertebræ in the Sprat are 48 in number, in the Herring there are 56, as I have ascertained upon many examples of both species.

The number of vertebræ in the Whitebait and Herring being the same might suggest the idea that the Whitebait were young Herrings, but the œconomy of the species prevents this conclusion. The Whitebait are unknown on the shores of our various Northern islands, where the Herrings in myriads deposit their spawn; and on the other hand, the Thames produces Whitebait in abundance during the summer, remaining with us till August, when the Herrings are heavy with roe which they do not deposit till October.

XXXVIII. *On a Property possessed in common by the Primitives and Derivatives of the Product of two Monome Functions.* By Mr. EDWARD SANG*.

THE idea expounded by Lagrange, of regarding the successive differential coefficients of a function of one variable, as similar functions derived from each other, according to a given law, materially changes the aspect of the fluxional calculus. His confined notation, however, which is almost a return to the inconvenient method of Newton, prevents the advantages of his system from being generally appreciated, and divests it of that perspicuity which ought always to be the characteristic of algebraic notation. The elegance of his methods, as well as their great power, interested me in procuring a more convenient notation,—one which might enable me to pass from one primary to another without being distracted by the confusion which arises from his varied accents.

In denoting a derived function it is evidently necessary to indicate both the number of times the derivation has been repeated, and the quantity which, in these operations, has been regarded as the independent or primary variable. Of the three notations which have been employed, that of Leibnitz alone serves both of these purposes; but from its complexity, as well as from its fractional appearance, it is any thing but convenient in complex operations.

The particular theorem, which it is my intention in this paper to expound, I have been unable to express by the notation either of Lagrange or Leibnitz, without introducing an extension of signification too far-fetched to be admissible; and am therefore compelled to explain the particular algorithm which conducted me to the result in question.

If u be a function of z I propose to denote the differential coefficient $\frac{du}{dx}$ of Leibnitz or the "*fonction prime* u′" of Lagrange by the expression ${}_{1z}u$; the second differential coefficient $\frac{d^2u}{dx^2}$ or the *fonction seconde* u″ by ${}_{2z}u$, and so on.

This notation, in the first place, enables us to express in a very clear manner those complex derivatives which are obscurely indicated by such expressions as $\frac{d^5u}{dx^3\,dz^2}$, which from analogy one would be very apt to suppose equivalent to $\frac{d^5u}{dx^5}\left(\frac{dx}{dz}\right)^2$. In fact the quantity intended by the first of these expressions, being obtained by deriving three times with x as a primary

* Communicated by the Author.

x primary and twice with the primary *z*, may be easily expressed by ${}_{3x\,.\,2z}u$; while that indicated by the second can be denoted by $5xu\,({}_{1z}x)^2$ or ${}_{5x}u\;{}_{1z}x^2$.

The series of quantities

$$u,\ {}_{1z}u,\ {}_{2z}u,\ {}_{3z}u,\ {}_{4z}u,\ \&c.$$

being similarly derived, each from that which precedes, the derivatives of any one of them may be found by increasing its numerical subponent. Thus the second derivative of ${}_{3z}u$ is ${}_{5z}u$, and in general ${}_{nz}({}_{tz}u) = {}_{(t+n)z}u$.

Again, each member of the series being the derivative of that which precedes, may in turn be regarded as the primitive of that which follows, so that the second primitive of ${}_{5z}u$ is ${}_{3z}u$. The operation of integrating or going back in the series, may therefore be conveniently expressed by prefixing the negative sign to the subponent, so that ${}_{-1z}u$ means the primitive of the function u, the primary variable being z; ${}_{-2z}u$, the second primitive, and so on. We have thus in general

$${}_{-nz}({}_{tz}u) = {}_{(t-n)z}u$$

and also ${}_{5z}u = u$. In this manner an advantage accrues to the notation similar to that which follows from the employment of negative exponents.

The quantities

$$\&c.,\ {}_{-3z}u,\ {}_{-2z}u,\ {}_{-1z}u,\ u,\ {}_{1z}u,\ {}_{2z}u,\ {}_{3z}u,\ \&c.$$

thus form an uninterrupted series, any one of which may be regarded as the original from which the others were deduced; thus, if ${}_{1z}u = v$, the same quantities might have been written

$$\&c.\ {}_{-4z}v,\ {}_{-3z}v,\ {}_{-2z}v,\ {}_{-1z}v,\ v,\ {}_{1z}v,\ {}_{2z}v,\ \&c.$$

This resemblance of primitive and derivative functions is not the mere consequence of an artificial notation; they possess properties in common, one of the most remarkable, and at the same time most easily investigated of which, I proceed to demonstrate.

It has been shown (Bossut, *Traité de Calcul*, page 103; Lacroix, *Diff. Cal. Transl.* p. 11) that $\frac{d(u\,v)}{d\,z} = u\,\frac{d\,v}{d\,z} + v\,\frac{d\,u}{d\,z}$ or (Lagrange, *Theorie des Fonctions*, page 26) that $(u\,v)' = u'\,v + u\,v'$, which theorem, in our notation, is expressed by

$${}_{1z}(u\,v) = {}_{1z}u\,v + u\;{}_{1z}v$$

Taking

Taking the first derivative of each member of this equation, we obtain

$${}_{2z}(uv) = {}_{1z}({}_{1z}u\,v) + {}_{1z}(u\,{}_{1z}v)\text{; but, by the same theorem}$$

$${}_{1z}({}_{1z}u\,v) = {}_{2z}u\,v + {}_{1z}u\,{}_{1z}v$$

and

$${}_{1z}(u\,{}_{1z}v) = {}_{1z}u\,{}_{1z}v + u\,{}_{2z}v\text{, wherefore}$$

$${}_{2z}(uv) = {}_{2z}u\,v + 2\,{}_{1z}u\,{}_{1z}v + u\,{}_{2z}v.$$

Applying the same method repeatedly to this equation we obtain

$${}_{3z}(uv) = {}_{3z}u\,v + 3\,{}_{2z}u\,{}_{1z}v + 3\,{}_{1z}u\,{}_{2z}v + u\,{}_{3z}v;$$

$${}_{4z}(uv) = {}_{4z}u\,v + 4\,{}_{3z}u\,{}_{1z}v + 6\,{}_{2z}u\,{}_{2z}v + 4\,{}_{1z}u\,{}_{3z}v + u\,{}_{4z}v;$$

&c. &c.

Where the order of the subponents is exactly similar to that of the exponents of the integer positive powers of a binomial, and where the numerical coefficients are formed in the same manner. Hence in general, n being a whole positive number,

$${}_{nz}(uv) = {}_{nz}u\,v + \frac{n}{1}\,{}_{(n-1)z}u\,{}_{1z}v + \frac{n}{1}\,\frac{n-1}{2}\,{}_{(n-2)z}u\,{}_{2z}v + \&c.$$

And it is my object to show that the same theorem applies when n is a negative integer. But before proceeding to that part of my subject, I may notice a very simple extension of the above theorem.

As such expressions as $\frac{{}_{5z}u}{1.2.3.4.5}$; $\frac{z^7}{1.2\ldots\ldots7}$ are of very frequent occurrence in investigations of this kind, they may conveniently be denoted by ${}_{5z}\underline{u}$ and $\underline{z^7}$; this premised, the above equation, dividing each side by $1.2.3\ldots\ldots n$, becomes

$${}_{nz}\underline{uv} = {}_{nz}\underline{u}\,v + {}_{(n-1)z}\underline{u}\,{}_{1z}\underline{v} + {}_{(n-2)z}\underline{u}\,{}_{2z}\underline{v} + \&c.$$

$$= \Sigma\,.\,{}_{az}\underline{u}\,{}_{(n-a)z}\underline{v}$$

Extending the same reasoning to a product of three functions, we have

$${}_{nz}\underline{uvw} = \Sigma\,.\,{}_{az}\underline{u}\,{}_{bz}\underline{v}\,{}_{(n-a-b)z}\underline{w}\text{; also}$$

$${}_{nz}\underline{uvwx} = \Sigma\,.\,{}_{az}\underline{u}\,{}_{bz}\underline{v}\,{}_{cz}\underline{w}\,{}_{(n-a-b-c)z}\underline{x}$$

in which expressions a, b, c, &c. must receive, combined in all possible ways, every integer value from 0 to n.

Resuming the original equation ${}_{1z}(Uv) = {}_{1z}U\,v + U\,{}_{1z}v$, and supposing $U = {}_{-1z}u$, and consequently ${}_{1z}U = u$, we have

$${}_{1z}({}_{-1z}u\,v) = uv + {}_{-1z}u\,{}_{1z}v$$

whence

whence taking the first primitive, and transposing

$${}_{-1z}(u\,v) = {}_{-1z}u\,v - {}_{-1z}({}_{-1z}u\;{}_{1z}v)$$

but in the very same manner

$${}_{-1z}({}_{-1z}u\;{}_{1z}v) = {}_{-2z}u\;{}_{1z}v - {}_{-1z}({}_{-2z}u\;{}_{2z}v)$$

$${}_{-1z}({}_{-2z}u\;{}_{2z}v) = {}_{-3z}u\;{}_{2z}v - {}_{-1z}({}_{-3z}u\;{}_{3z}v) \;\&c.$$

whence by the substitution of these values

$${}_{-1z}(u\,v) = {}_{-1z}u\,v - {}_{-2z}u\;{}_{1z}v + {}_{-3z}u\;{}_{2z}v - {}_{-4z}u\;{}_{3z}v + \&c.$$

Taking again the first primitive of each member of this equation, expanding the partial results, and adding, we find

$${}_{-2z}(u\,v) = {}_{-2z}u\,v - 2\;{}_{-3z}u\;{}_{1z}v + 3\;{}_{-4z}u\;{}_{2z}v - 4\;{}_{-5z}u\;{}_{3z}v + \&c.$$

By treating this repeatedly in the same manner, we should arrive at expressions closely resembling the expansions of the negative powers of a binomial; and should obtain in general

$${}_{-mz}(u\,v) = {}_{-mz}u\,v - \frac{m}{1}\;{}_{-(m+1)z}u\;{}_{1z}v + \frac{m}{1}\,\frac{m+1}{2}\;{}_{-(m+2)z}u\;{}_{2z}v - \&c.$$

where, if we change m into $-n$, we have

$${}_{nz}(u\,v) = {}_{nz}u\,v - \frac{n}{1}\;{}_{(n-1)z}u\;{}_{1z}v + \&c.$$

exactly the expression which we before found for derivatives.

In the investigation of the formula for primitives no notice has been taken of the arbitrary constants which at each step enter into the calculation, and it therefore becomes necessary to examine whether the omission has not vitiated the result, it being a well known fact that the equality of two functions does not necessarily imply that of their primitives.

The arbitrary part of a first primitive being of the form a, that of a second primitive must be $az + b$; of a third primitive $a\underline{z}^2 + bz + c$; of a fourth $a\underline{z}^3 + b\underline{z}^2 + cz + d$; and, in general, of a primitive of the nth order the arbitrary part is

$$a\,\underline{z}^{n-1} + b\,\underline{z}^{n-2} + c\,\underline{z}^{n-3} + \&c.\ldots + p\,z + q.$$

If in the value of ${}_{-1z}(u\,v)$ we annex to the successive primitives of u these arbitrary parts, the former value of this primitive will be increased by the following quantity:

$$\begin{array}{l}
a\{v - {}_{1z}v\,z + {}_{2z}v\,\underline{z}^2 - {}_{3z}v\,\underline{z}^3 + {}_{4z}v\,\underline{z}^4 - \&c.\} \\
+\, b\{- {}_{1z}v + {}_{2z}v\,z - {}_{3z}v\,\underline{z}^2 + {}_{4z}v\,\underline{z}^3 - \&c.\} \\
+\quad c\;\{+ {}_{2z}v - {}_{3z}v\,z + {}_{4z}v\,\underline{z}^2 - \&c.\} \\
\qquad\qquad + d\,\{- {}_{3z}v + {}_{4z}v\,z - \&c.\} \\
\qquad\qquad\qquad + e\,\{+ {}_{4z}v - \&c.\} \\
\qquad\qquad\qquad\qquad + \&c.
\end{array}$$

 which

which at first sight appears to involve not only every positive integer power of z, but even, since v is any function of z, its fractional powers.

We have, however, $\phi(z+dz) = \phi z + {}_{1z}\phi z\, dz + {}_{2z}\phi z\, \underline{dz^2} +$ &c. in which if we make $dz = -z$, and change ϕz into v,* we obtain

$$\phi(z-z) = \phi o = v - {}_{1z}v z + {}_{2z}v \underline{z^2} - {}_{3z}v \underline{z^3} + \text{\&c.}$$

and by changing ϕz into ${}_{1z}v$

$${}_{1z}\phi(z-z) = {}_{1z}\phi o = {}_{1z}v - {}_{2z}v z + {}_{3z}v \underline{z^2} - \text{\&c.}$$

Now all such expressions as ϕo being constant quantities, it follows that, by the addition of an arbitrary constant at each integration of u, a constant quantity only has been annexed to the first primitive of $u v$, and therefore the superior primitives cannot be affected by powers of z so high as the order of the primitive.

Having thus shown that the omission of the arbitrary parts has not rendered our result less general, I may proceed to illustrate its utility by a single example.

Let the 7th primitive of $z^3 . \sin z$ be required. Here making $z^3 = v$, $\sin z = u$, we have

$${}_{-7z}(z^3 \sin z) = {}_{-7z}\sin z \,.\, z^3 - \tfrac{7}{1}\, {}_{-8z}\sin z \,.\, 3z^2 + \tfrac{7}{1}\tfrac{8}{2}\, {}_{-9z}\sin z \,.\, 6z$$

$$-\tfrac{7}{1}\tfrac{8}{2}\tfrac{9}{3}\, {}_{-10z}\sin z \,.\, 6.$$ Or, since ${}_{-7z}(\sin z) = \cos z$; ${}_{-8z}\sin z = \sin z$; ${}_{-9z}\sin z = -\cos z$; and ${}_{-10z}\sin z = -\sin z$

$${}_{-7z}(z^3 \sin z) = \cos z \,.\, z^3 - 21 \sin z \,.\, z^2 - 168 \cos z \,.\, z + 504 \sin z.$$

And it appears from this example that, of the functions u and v, whenever the primitives of the one are known and the number of derivatives of the other finite, the integral of the product will be obtained in finite terms; in all other cases the result will be in the form of an interminate series. It may also be noticed that two distinct expressions may be obtained, the one combining the primitives of u with the derivatives of v, and the other the derivatives of u with the primitives of v.

When the expression to be integrated cannot be separated into two factors, it may have the multiplier z° supplied, which artifice would give

$${}_{-mz}y = {}_{-mz}(y z^\circ) = z^m y - \frac{m}{1}\underline{z}^{m+1}\, {}_{1z}y + \frac{m}{1}\frac{m+}{2}\underline{z}^{m+2}\, {}_{2z}y - \text{\&c.}$$

$$= \frac{1}{1.2\ldots(m-1)}\left\{\frac{z^m}{m}\, y - \frac{z^{m+1}}{m+1}\, {}_{1z}\underline{y} + \frac{z^{m+2}}{m+2}\, {}_{2z}\underline{y} - \text{\&c.}\right\}$$

which

which may be regarded as a general formula for the integration of functions of all kinds.

32, St. Andrew-square, Edinburgh,
August 7, 1829.
EDWARD SANG.

XXXIX. *Formulæ and Tables for calculating the Apparent Places of Fixed Stars, as given by Professor* BESSEL.

(*From* Prof. Encke's *Ephemeris for* 1830, *p.* 158–198.)

General precession... 50″·231

$$A = t - 0{\cdot}02652 \sin 2\odot - 0{\cdot}33316 \sin \Omega + 0{\cdot}00401 \sin 2\Omega$$
$$B = -0''{\cdot}580 \cos 2\odot - 8''{\cdot}977 \cos \Omega + 0''{\cdot}088 \cos 2\Omega$$
$$C = -20{\cdot}255 \cos \varepsilon \cos \odot$$
$$D = -20{\cdot}255 \sin \odot$$

$$a = 46''{\cdot}053 + 20''{\cdot}057 \operatorname{tg} \delta \sin \alpha$$
$$b = \operatorname{tg} \delta \cos \alpha$$
$$c = \sec \delta \cos \alpha$$
$$d = \sec \delta \sin \alpha$$

$$a' = 20''{\cdot}057 \cos \alpha$$
$$b' = -\sin \alpha$$
$$c' = \operatorname{tg} \varepsilon \cos \delta - \sin \delta \sin \alpha$$
$$d' = \sin \delta \cos \alpha$$

m proper motion right in ascension.
m' proper motion in declination.
t days from the beginning of the year expressed in parts of the year.

$$\text{App. Æ} = \text{Æ } 1830 + Aa + Bb + Cc + Dd + tm$$

$$\text{App. Decl.} = \text{Decl. } 1830 + Aa' + Bb' + Cc' + Dd' + tm'$$

If we assume

$$A\ 20''{\cdot}057 = g \cos G \qquad D = h \cos H$$
$$B = g \sin G \qquad C = h \sin H$$
$$A\ 46''{\cdot}053 = f \qquad C \operatorname{tg} \varepsilon = i$$

We shall have

$$\text{App. Æ} = \text{Æ } 1830 + f + tm + g \sin (G + \alpha) \operatorname{tg} \delta + h \sin (H + \alpha) \sec \delta.$$

$$\text{App. Decl.} = \text{Decl. } 1830 + i \cos \delta + tm' + g \cos (G + \alpha) + h \cos (H + \alpha) \sin \delta$$

The following Tables contain the values of α and δ for the beginning of the year, together with the values of the constants here introduced, or their logarithms, for every 10th day of the year:

Mean Places of the principal Stars for 1830, *according to* Prof. Bessel's *Determination.*

Names.	Mean Æ 1830.	Annual Variation 1830.	Mean Declination 1830.	Annual Variation 1830.
	h ′ ″			
γ Pegasi	0 4 29·455	+3″·0795	+14° 14′ 16″·49	+20·026
α Cassiop. ...	0 30 54·657	+3·3389	+55 36 12·67	+19·828
α Arietis......	1 57 36·404	+3·3576	+22 39 15·70	+17·325
α Ceti.........	2 53 24·030	+3·1237	+ 3 25 2·42	+14·459
α Persei	3 12 13·766	+4·2299	+49 14 54·09	+13·357
α Tauri	4 26 10·416	+3·4303	+16 9 35·48	+ 7·809
α Aurigæ	5 4 8·595	+4·4148	+45 48 53·59	+ 4·415
β Orion.......	5 6 22·224	+2·8787	− 8 24 17·82	+ 4·620
β Tauri	5 15 33·058	+3·7861	+28 27 17·25	+ 3·658
α Orion.......	5 45 58·190	+3·2455	+ 7 22 3·12	+ 1·220
α Can. maj...	6 37 39·268	+2·6441	−16 29 22·17	· 4·521
α Gemin.* ...	7 23 44·061	+3·8424	+32 15 8·89	− 7·243
α Can. min. ..	7 30 23·907	+3·1469	+ 5 39 12·74	− 8·779
β Gemin......	7 34 54·069	+3·6845	+28 25 41·42	− 8·136
α Hydræ......	9 19 13·891	+2·9473	− 7 55 34·55	−15·300
α Leonis......	9 59 18·576	+3·2045	+12 47 40·36	−17·333
α Urs. maj. ...	10 53 9·761	+3·7963	+62 39 59·99	−19·305
β Leonis......	11 40 22·910	+3·0663	+15 31 19·19	−20·087
β Virgin.	11 41 50·365	+3·1244	+ 2 43 19·90	−20·292
γ Urs. maj. ...	11 44 51·166	+3·2092	+54 38 22·67	−20·035
α Virgin.......	13 16 14·849	+3·1465	−10 16 17·88	−19·012
η Urs. maj. ...	13 40 50·026	+2·3778	+50 9 51·81	−18·172
α Bootis	14 7 54·573	+2·7324	+20 4 15·45	−18·987
1α Libræ	14 41 17·870	+3·3008	−15 17 7·16	−15·374
2α Libræ	14 41 29·250	+3·3028	−15 19 48·63	−15·343
β Urs. min. ...	14 51 17·597	−0·2915	+74 51 0·58	−14·760
α Coronæ	15 27 29·506	+2·5365	+27 17 29·76	−12·453
α Serpent. ...	15 35 53·992	+2·9494	+ 6 57 57·10	−11·756
α Scorpii......	16 18 59·827	+3·6624	−26 2 49·25	− 8·601
α Herculis....	17 6 53·940	+2·7308	+14 35 24·50	− 4·575
α Ophiuch....	17 27 2·704	+2·7773	+12 41 24·61	− 3·085
γ Dracon.	17 52 39·741	+1·3929	+51 30 42·51	− 0·699
α Lyræ.....	18 31 10·981	+2·0301	+38 37 47·54	+ 2·991
γ Aquilæ......	19 38 10·646	+2·8549	+10 12 17.02	+ 8·324
α Aquilæ......	19 42 29·280	+2·9285	+ 8 25 30·90	+ 9·040
β Aquilæ.......	19 46 57·776	+2·9500	+ 5 59 15·90	+ 8·525
1α Capric.	20 8 13·160	+3·3327	−13 1 39·57	+10·622
2α Capric. ...	20 8 37·014	+3·3371	−13 3 57·19	+10·650
α Cygni....	20 35 38·294	+2·0412	+44 40 34·21	+12·586
α Cephei	21 14 30·988	+1·4404	+61 52 1·44	+15·036
β Cephei	21 26 26·099	+0·8131	+69 48 54·97	+15·658
α Aquarii.....	21 57 3·000	+3·0836	− 1 8 33·42	+17·218
α Pisc. austr.	22 48 14·510	+3·3391	−30 31 20·25	+18·851
α Pegasi	22 56 17·880	+2·9815	+14 17 31·69	+19·270
α Androm....	23 59 36·906	+3·0786	+28 9 5·65	+19·906

* In α Gemin. the Right Ascension is the mean of that of both stars; the Declination that of the one which follows.

Constants for the Sidereal Days in 1830.

1830.		Log. A.	Log. B.	Log. C.	Log. D.	Log. *t*.
Jan.	0	8·5110$_n$	0·9796	0·5091$_n$	1·2999	......
	10	6·1461$_n$	0·9743	0·8068$_n$	1·2790	8·4362
	20	8·4771	0·9664	0·9722$_n$	1·2426	8·7372
	30	8·7579	0·9567	1·0812$_n$	1·1879	8·9133
Feb.	9	8·9101	0·9462	1·1569$_n$	1·1095	9·0383
	19	9·0093	0·9362	1·2093$_n$	0·9971	9·1352
March	1	9·0802	0·9277	1·2438$_n$	0·8270	9·2144
	11	9·1349	0·9219	1·2632$_n$	0·5190	9·2813
	21	9·1808	0·9194	1·2690$_n$	9·2718$_n$	9·3393
	31	9·2225	0·9205	1·2619$_n$	0·5625$_n$	9·3905
April	10	9·2634	0·9248	1·2415$_n$	0·8445$_n$	9·4362
	20	9·3051	0·9316	1·2069$_n$	1·0047$_n$	9·4776
	30	9·3483	0·9398	1·1556$_n$	1·1113$_n$	9·5154
May	10	9·3928	0·9484	1·0835$_n$	1·1861$_n$	9·5502
	20	9·4379	0·9563	0·9824$_n$	1·2391$_n$	9·5823
	30	9·4825	0·9626	0·8340$_n$	1·2751$_n$	9·6123
June	9	9·5255	0·9665	0·5870$_n$	1·2969$_n$	9·6403
	19	9·5660	0·9677	9·9058$_n$	1·3061$_n$	9·6667
	29	9·6033	0·9659	0·3566	1·3033$_n$	9·6915
July	9	9·6370	0·9610	0·7233	1·2882$_n$	9·7150
	19	9·6668	0·9536	0·9116	1·2660$_n$	9·7372
	29	9·6926	0·9441	1·0338	1·2168$_n$	9·7584
Aug.	8	9·7148	0·9332	1·1195	1·1550$_n$	9·7786
	18	9·7335	0·9221	1·1809	1·0682$_n$	9·7979
	28	9·7493	0·9117	1·2239	0·9432$_n$	9·8164
Sept.	7	9·7627	0·9031	1·2519	0·7469$_n$	9·8342
	17	9·7746	0·8974	1·2664	0·3459$_n$	9·8512
	27	9·7857	0·8952	1·2682	0·0903	9·8676
Oct.	7	9·7968	0·8966	1·2572	0·6687	9·8834
	17	9·8085	0·9014	1·2325	0·9018	9·8986
	27	9·8213	0·9085	1·1920	1·0442	9·9133
Nov.	6	9·8356	0·9171	1·1323	1·1413	9·9276
	16	9·8515	0·9258	1·0469	1·2098	9·9414
	26	9·8686	0·9333	0·9225	1·2573	9·9547
Dec.	6	9·8866	0·9386	0·7260	1·2880	9·9677
	16	9·9049	0·9407	0·3228	1·3037	9·9803
	26	9·9228	0·9394	0·0741$_n$	1·3057	9·9925
	36	9·9398	0·9345	0·6474$_n$	1·2938	0·0044

k. −1·178

n means, as usual, that the quantity whose log. is given is negative.

The

The argument of the preceding table for sidereal days is found as follows. If we call

θ ... the sidereal time of the observation expressed in parts of a day.

l ... the longitude of the place of observation counted from the meridian of Berlin, expressed in parts of a day, and negative if east, positive if west;

1. For $\theta < 18^h\ 40'$

from the beginning of the year to the day on which $Æ\odot = \theta$.

$$\text{Argument} = \text{date} + \theta + k + l + 1$$

from that day to the end of the year

$$\text{Argument} = \text{date} + \theta + k + l + 2$$

2. For $\theta > 18^h\ 40'$

from the beginning of the year to the day on which $Æ\odot = \theta$.

$$\text{Argument} = \text{date} + \theta + k + l$$

from that day to the end of the year

$$\text{Argument} = \text{date} + \theta + k + l + 1$$

In the following table for the mean days it is simply mean time.

Constants for the Mean Days in 1830.

1830.	*f*	*g*	G	*h*	H	*i*
	″	″	° ′	″	° ′	″
Jan. 0	−1·50	+9·57	93 54	+20·21	351 11	−1·34
10	−0·01	9·43	90 0	20·07	341 44	2·72
20	+1·39	9·28	86 15	19·85	332 7	4·02
30	2·64	9·13	82 44	19·58	322 17	5·20
Feb. 9	3·76	8·99	79 28	19·28	312 10	6·20
19	4·73	8·88	76 34	19·00	301 48	7·01
March 1	5·57	8·81	73 59	18·78	291 12	7·60
11	6·32	8·80	71 45	18·63	280 26	7·95
21	7·02	8·85	69 46	18·58	269 37	8·06
31	7·73	8·98	67 58	18·64	258 51	7·94
April 10	+8·49	+9·19	66 15	+18·79	248 17	−7·57
20	9·34	9·46	64 31	19·01	237 58	6·99
30	10·32	9·80	62 40	19·28	227 59	6·22
May 10	11·43	10·18	60 42	19·56	218 20	5·26
20	12·68	10·60	58 34	19·82	208 59	4·17
30	14·05	11·03	56 17	20·04	199 53	2·96
June 9	15·51	11·46	53 52	20·19	191 0	1·67
19	17·03	11·88	51 22	20·25	182 13	−0·34
29	18·55	12·28	48 50	20·23	173 27	+1·00
July 9	20·04	12·64	46 19	20·12	164 39	2·31

July

TABLE (*continued*).

1830.		*f*	*g*	G	*h*	H	*i*.
		″	″	° ′	″	° ′	″
July	19	+21·45	+12·97	43 51	+19·94	155 42	+3·56
	29	22·77	13·26	41 32	19·70	146 33	4·71
Aug.	8	23·95	13·51	39 23	19·43	137 8	5·74
	18	25·00	13·73	37 28	19·15	127 25	6·60
	28	25·93	13·94	35 49	18·90	117 22	7·28
Sept.	7	26·75	14·14	34 27	18·71	107 3	7·76
	17	27·49	14·35	33 23	18·60	96 30	8·02
	27	28·20	14·59	32 35	18·59	85 50	8·05
Oct.	7	28·93	14·87	32 1	18·68	75 9	7·84
	17	29·72	15·21	31 37	18·86	64 33	7·39
	27	+30·62	+15·62	31 17	+19·11	54 8	+6·72
Nov.	6	31·65	16·08	30 57	19·39	43 58	5·84
	16	32·83	16·61	30 32	19·68	34 2	4·78
	26	34·17	17·19	29 58	19·94	24 21	3·57
Dec.	6	35·62	17·79	29 14	20·13	14 50	2·24
	16	37·14	18·39	28 20	20·24	5 27	+0·83
	26	38·71	18·98	27 17	20·25	356 6	−0·60
	36	40·25	19·53	26 6	20·16	346 43	−2·01

The places of the stars ought strictly to be corrected for the *daily* aberration, before they are compared with the observations.

If $+ t$ is the eastern hour angle, ϕ the altitude of the pole, δ the declination of a star;

The correction in right ascension is $+ 0''{\cdot}021 \frac{\cos\varphi \,.\, \cos t}{\cos\delta}$ in time.

The correction of the declination is

$$-0''{\cdot}31 \cos\varphi \,.\, \sin t \,.\, \sin\delta \text{ in seconds of a degree.}$$

For the superior culmination we have

$$d\alpha = + 0''{\cdot}021 \cos\phi \,.\, \sec\delta \text{ in time, } d\delta = 0$$

For the inferior culmination we have

$$d\alpha = - 0''{\cdot}021 \cos\varphi \,.\, \sec\delta \text{ in time, } d\delta = 0$$

that is to say, the observations must be thus corrected:

Sup. Culm. $- 0''{\cdot}021 \cos\varphi \,.\, \sec\delta$
Inf. Culm. $+ 0''{\cdot}021 \cos\varphi \,.\, \sec\delta$.

[Having now given whatever is susceptible of translation in Prof. Encke's Ephemeris for 1830; we hope in some future Number to be able to give what is interesting from the volume for 1831, which has lately been published.—EDIT.]

XL. *Some*

XL. *Some Remarks on an Article in the* "Bulletin des Sciences Mathematiques" *for June* 1829, § 269. *By* JAMES IVORY, *Esq. M.A. F.R.S. &c.**

AS I am preparing a treatise on the Theory of the Figure of the Earth, I had resolved to take no notice of the objections advanced against the physical conditions I had found necessary for the equilibrium of a planet supposed fluid and homogeneous: the observations in the *Bulletin* have induced me to depart a little from the resolution I had adopted.

I shall use the symbols C and A to denote, respectively, the whole mass of the planet; and any interior portion bounded by a continuous surface. We shall succeed best in throwing light on this subject if we begin with estimating the forces that act upon a molecule of the fluid in the surface of A. I shall demonstrate that, when all that is implied in the hypothesis of the problem is taken into account, there are three distinct forces which act upon every such molecule; whereas, according to Clairaut's theory, there are only two of the same forces in action, the third being omitted. But, it may be observed, this is not to be ascribed to any imperfection of the theory mentioned; for the force neglected cannot possibly be included in any general theory, because it is a consequence of the particular hypothesis of the problem.

In the surface of A assume a molecule of the fluid which I shall call m. As the author in the *Bulletin* has estimated the forces acting upon m, which he represents by R, R$'$, R$''$, I shall borrow from him. The first force R is the resultant of the centrifugal force and the attraction of A. The second force R$'$ is the action upon m of the stratum C—A, caused by all the forces that urge the particles of the stratum. The third force R$''$ is the action upon m, caused by the attraction of the stratum C—A upon the particles of A. According to the hypothesis of the problem all the matter of C—A will attract every particle of A; and these attractive forces must produce pressures which, being propagated from particle to particle, will urge m, and every molecule in the surface of A, to move from its place. Suppose that the centre of gravity of C—A falls within A, and conduct a canal from that centre to m: then the effect of R$''$ perpendicular to the surface of A is equal to the hydrostatic pressure caused by the attraction of C—A upon the fluid in the canal. The force R$''$ is therefore perfectly well defined; and, from what is said, it is easy to find the analytical expressions of the partial forces, parallel to the co-

* Communicated by the Author.

ordinates,

ordinates, of which R″ is the resultant. Now the equations of Clairaut's theory comprehend only the two forces R and R′, and omit the third force R″. For that theory computes only the accelerating forces that act directly upon any particle of the fluid; whereas R″ is a secondary force caused by the attraction between two portions of the mass of fluid. The least attention is sufficient to show that the same force cannot possibly be included in any general theory applicable in all cases; because it is the effect of a particular hypothesis.

What has just been said demonstrates the insufficiency of Clairaut's theory for solving the problem of the equilibrium of a planet in a fluid state. It is not a mathematical difficulty that has obstructed the progress of this research since the time of Newton; it is the want of a clear conception of the physical conditions of the problem, and the omitting of some of the forces required for the equilibrium. Clairaut's theory, although perfectly just when properly applied, has occasioned geometers to waste their labour in attempting to solve analytical equations which do not comprehend all that is necessary to determine the question.

It would serve no good purpose to reply to the objections of the author in the *Bulletin*. His arguments, as well as those formerly advanced by M. Poisson, are chargeable with inconsistency: for both these writers admit the attraction of C—A upon the particles of A, and estimate its effects; and although that attraction is left out in Clairaut's theory, yet they uphold the sufficiency of his equations for solving the problem*.

If A be similar to C and similarly posited about the centre of gravity of the planet, I have proved that A will be *in equilibrio* separately, supposing the exterior matter is taken away or annihilated. In this case, therefore, the force R will be perpendicular to the surface of A; and as the three forces that urge *m* must be *in equilibrio*, it follows that the resultant of R′ and R″ must be perpendicular to the same surface. And because the resultant of the two forces is perpendicular to the surface of A, their joint action will produce the same intensity of pressure upon every point of the surface, which is therefore one of equable pressure. This has been proved before, and it mostly removes the difficulty of solving the problem. For, these surfaces of equable pressure being all de-

* In particular M. Poisson has estimated the pressure upon *m* caused by the attraction of C—A upon a canal within A. Now this pressure coexists with the centrifugal force and the attraction of all the matter of the planet upon *m*: and, as the two latter forces alone are included in Clairaut's equations, it is evident that his theory is insufficient to solve the problem.

rived from the surface of the planet by the same determinate construction, it only remains to find the figure that will reconcile them with the forces that prevail in the interior of the fluid. It will be found that the condition, $R'' = 0$, is indispensably required; which limits the figure of equilibrium to the elliptical spheroid.

Whenever the resultant of the forces R' and R'' is perpendicular to the surface of A, that surface will be one of equable pressure. Now there are two ways in which this may happen: each force may be separately perpendicular to the surface, as when A is similar to the planet and similarly posited about the centre of gravity, which requires the condition $R'' = 0$; or the resultant may be perpendicular to the surface, although both the forces be oblique to it. When the forces are computed, the analytical investigation will be found to bring out the same equation of the surface of A in both cases; but this equation admits of two solutions, which determine the two surfaces of equable pressure. Thus in every elliptical spheroid *in equilibrio* there are two sorts of surfaces of equable pressure, both elliptical but differing in their figure. Further, the planet being *in equilibrio*, any interior body, as A, bounded by a surface of equable pressure, will be *in equilibrio* separately, the stratum C—A being taken away; and hence we learn the reason why, the data of the problem being the same, there are two, and only two, different figures of equilibrium.

Clairaut's theory may be reconciled with one of the sets of surfaces of equable pressure, because the force R'' which that theory leaves out, disappears on account of the condition $R'' = 0$: but the co-existence of two different surfaces of equable pressure in the same mass of fluid *in equilibrio* is entirely incompatible with the theory in question.

What has been said proves that all the researches founded on Clairaut's theory, which makes the perpendicularity of gravity to the surface of the planet the sole condition of equilibrium, must fail in leading to an exact solution of the problem; although in some cases they may bring out an approximation. Of all the possible figures possessing the property mentioned, the oblate elliptical spheroid is the only one which at the same time fulfils all the conditions that are true in nature. On the whole, there is, in reality, no part of the theory of the equilibrium of a planet perfectly established on exact principles except the synthetic demonstration given long ago by Maclaurin with all the elegance and rigour of the ancient geometry. These observations may suffice at present on this subject, which requires to be reviewed and treated anew from first principles.

The

The article in the *Bulletin* likewise slightly touches upon Laplace's development, with respect to which M. Poisson has inserted a note in the *Conn. des Tems*, 1831. The last researches of M. Poisson coincide entirely with what I have all along asserted; namely, that the development is applicable only to rational functions of $\cos\theta$, $\sin\theta\cos\psi$, $\sin\theta\sin\psi$; and of this they, in reality, furnish a clear demonstration. He has proved that the development converges, when $y = f(\theta', \psi')$, has the meaning he affixes to it; so that taking n equal to a finite, although perhaps a very great number, we shall have with sufficient exactness,

$$y = Y^{(0)} + Y^{(1)} + Y^{(2)} \ldots\ldots\ldots + Y^{(n)}.$$

Now it is certain that every term of this series is, necessarily by its very structure, a rational function of $\cos\theta$, $\sin\theta\cos\psi$, $\sin\theta\sin\psi$; and therefore the aggregate of any number of such terms is a function of the same kind. And this conclusion does not rest upon M. Poisson's demonstrations; it depends upon the convergency of the series, that is, upon its capability of expressing a determinate value. No proposition can possibly be more clearly proved than this, That $f(\theta, \psi)$ cannot be developed according to the method of Laplace in a series of converging terms, unless it be equal, either exactly or approximately, to a rational expression of $\cos\theta$, $\sin\theta\cos\psi$, $\sin\theta\sin\psi$.

Every function $f(\theta, \psi)$ may be reduced by the ordinary rules of algebra to a rational expression, convergent or not, of $\cos\theta$, $\sin\theta\cos\psi$, $\sin\theta\sin\psi$; but it is only when the expression converges that Laplace's development can be applied with geometrical accuracy. The development adds nothing to the totality of the reduced expression, nor takes one iota away from it; it merely breaks every coefficient into many parts so as to allow a new arrangement in parcels, every one of which satisfies the fundamental equation in partial fluxions.

The subjects treated in this article are of considerable importance, and I may occasionally return to them, in order to remove every difficulty. They have given rise to a long contestation, actively carried on; and if I mistake not, the doctrine I have advanced has not always engaged the attention only of such authors as I have alluded to, who labour to improve science, but has sometimes been made a handle.

Sept. 13, 1829. J. Ivory.

XLI. *Notice of the Arrival of Twenty-four of the Summer Birds of Passage in the Neighbourhood of Carlisle, during the Year* 1829; *with Observations, &c. By* A CORRESPONDENT.

No.	English Specific Names.	Latin Generic and Specific Names.	When first observed.
	Quail	Coturnix vulgaris	May 23
	Swallow	Hirundo rustica .	April 9
3	House Martin	——— urbica..	27
4	Sand or River Martin .	riparia .	5
5	Swift	Cypselus apus	27
6	Goatsucker	Caprimulgus europæus.	May 12
7	Pied Flycatcher, male..	Muscicapa atricapilla. .	April 17
	—, female		—— 27
8	Spotted Flycatcher	———— Grisola.	May 12
9	Wheatear	Saxicola œnanthe ..	April 12
10	Whinchat	rubetra	May 3
11	Redstart, male	Sylvia phœnicurus .	April 17
	————, female......	———————	30
12	Grasshopper Warbler .	Curruca locustella	18
13	Sedge Warbler	——— salicaria ..	28
14	Greater Pettychaps ...	——— hortensis..	May 9
15	Wood Wren	——— sibilatrix .	—— 6
16	Blackcap	——— atricapilla .	April 25
17	Whitethroat	Sylvia .	29
18	Yellow Wren	Regulus trochilus ..	15
19	Yellow Wagtail	Motacilla flava.. ..	17
20	Field Lark or Titling ..	Aurhus trivialis.....	18
21	Cuckoo	Cuculus canorus ...	26
22	Wryneck	Yunx torquilla	18
23	Corncrake	Ortygometra crex .	18
24	Common Tern	Sterna Hirundo ...	May 6

Quail.—This bird may be considered scarce in the neighbourhood of Carlisle, and we believe is generally so throughout the county. It is, however, much more plentiful some years than others: this was the case last year, having heard it repeatedly in various situations; yet during the present summer we have not been able to detect its singular note either before or since the 23rd of May. One or two are almost annually killed in the autumnal months, and a few have been known to remain over the winter.

Swallow.—The appearance of the Swallow this year was remarkably early, particularly so, considering the severe weather that prevailed at the time of its arrival, and is we have reason to believe the earliest notice of its having been seen in this neighbourhood. We first observed it between two and three P.M. coursing the river Eden in a sheltered situation near Etterby, in company with eight or ten Sand-Martins,

Martins, and on our return the following day it was still in the same situation. Although daily upon the look-out, we could not see another until the 21st, on which day several were seen.

Pied Flycatcher.—All the writers upon British ornithology who have stated that this species is indigenous to Britain, appear to have done so more from conjecture than from any conclusive evidence; as we cannot find a single well-authenticated fact of its having been met with in this country during the winter season: indeed, all the testimony upon which any reliance can be placed is decidedly against the supposition that it is indigenous, and tends strongly to prove that it is only a summer bird of passage. For instance, Mr. Bolton in his *Harmonia Ruralis*, says that it visits the west riding of Yorkshire, and departs with its young in September. The Rev. Mr. Dalton of Copgrove, (also in the west riding of Yorkshire,) states that he has frequently seen it about his house in the summer, but does not recollect ever to have noticed it in the winter*. Dr. Heysham, in his Catalogue of Cumberland Animals, observes that the Pied Flycatcher appears about the same time as the Spotted, but is not so common; and for the last three years we have noticed it regularly during the spring and summer in Cumberland, but as yet have never been able to see, hear of, or procure a single specimen in the winter, notwithstanding we have repeatedly searched for it in all the winter months during the above period; nor can we find, from the inquiries we have made, that it has ever been seen at this season of the year in those parts of Westmorland where it constantly resorts to in great numbers.

The migration of this species appears to be principally confined to the northern counties, as it is seldom observed beyond Yorkshire, and rarely seen in the south of England, although it has occasionally been met with in Norfolk, Suffolk, Middlesex, Surrey, Dorsetshire; and Mr. Greaves, in his British Ornithology, states, that in the summer of 1812 he found a nest of this bird with young at Peckham, in Surrey. In some parts of Westmorland it is very plentiful, especially in the beautiful and extensive woods surrounding Lowther Castle, the magnificent and princely residence of the Earl of Lonsdale, where we have seen it in very great numbers, and where it has bred unmolested and almost unknown for years. On the contrary, we have reason to think it has not resorted to the vicinity of Carlisle more than five or six years, and as far as we

* See the Supplement to Montagu's Ornithological Dictionary.

have

have yet been able to ascertain, only to the locality where it is evidently upon the increase.

In this situation the males generally arrive about the middle of April, the females not until ten or fifteen days afterwards: they commence nidification early in May, and the young are excluded about the first or second week in June. We have hitherto invariably found their nests in the hole of a tree, sometimes at a considerable height, occasionally near the surface of the ground, and for two successive years in the stump of a felled tree. In texture and formation the nest is very similar to those of the Greater Pettychaps, Blackcap, and Whitethroat, being only slightly put together, composed almost entirely of small fibrous roots and dried grass, always lined with a little hair, and generally a few decayed leaves on the outer side, but entirely without moss. Their eggs vary in number: we have found their nests with five, six, and now and then with seven: their colour a pale green, and so greatly resemble the eggs of the Redstart, that it is frequently very difficult to distinguish them unless contrasted together: they are, however, far from being so elegantly made, of a rounder form, and rather less, weighing from 23 to 30 grains.

The males soon after their arrival, should the weather be at all favourable, will frequently sit for a considerable time on the decayed branch of a tree, constantly repeating their short, little varied, although far from unpleasing song, every now and then interrupted by the pursuit and capture of some passing insect. Their alarm-note is not very unlike the word *chuck*, which they commonly repeat two or three times when approached, and which readily leads to their detection. The manners and habits of the Pied Flycatcher have considerable affinity to those of the Redstart: they arrive about the same time, associate together, and often build in the same holes, for which they will sometimes contend. On one occasion we found a dead female Redstart in the nest of a Pied Flycatcher containing two eggs; and at another time, when both these species had nests within a few inches of each other, upon the Redstart's being removed, the female Redstart took forcible possession of the Flycatcher's nest, incubated the eggs, and brought up the young.

We have now (August 26th) two young Pied Flycatchers, taken from the nest on the 21st of last June, and should we succeed in our attempts to domesticate them, we may in all probability on some future occasion make a remark or two upon the change of their plumage from youth to maturity.

Wheatear.—We were not able to see the Wheatear before

fore the 12th of April, and then only a solitary male, notwithstanding we had repeatedly traversed the coast both in March and the beginning of April; and it was not until the 17th that we observed them in the more immediate vicinity of Carlisle.

Grasshopper Warbler.—The Grasshopper Warbler has been more abundant with us this year than usual; so much so, that we have been able to procure four specimens, and could have obtained more without much difficulty. These consisted of three males and one female: the plumage of the former nearly coincided with each other; but the female was entirely destitute of the brown spots on the breast, and all the under parts were of an uniform pale brown or buff colour. We have been induced to notice this circumstance, as it is stated that no material difference exists in the plumage of the sexes: should this not be an accidental occurrence, it is possible the females do not acquire these marks until the second or third year.

The stomachs of the whole were entirely filled with the elytra and remains of small coleopterous insects, principally belonging to the family *Curculionidæ* of Leach; and we could not discover the least vestige of any orthopterous insect, upon which they are supposed almost entirely to subsist, and which they are said to decoy by their remarkable note.

Dottrel (*Charadrius morinellus*).—At one time we had considerable hopes that we should have been able to have noticed the arrival of the Dottrel in this neighbourhood with some degree of accuracy, having lately ascertained that it had regularly for some years past resorted to some open ground contiguous to Scugh Dyke, situate upon Broad Field, about nine miles south-west from Carlisle. At this place they usually remained about ten days or a fortnight, when they in all probability took up their residence on Skiddaw and the adjoining mountains, where they annually breed. Early in May 1828 they were seen in the above situation in considerable numbers, and from fifteen to twenty were killed about the 9th of that month. It is perhaps not very generally known that some parts of the plumage of the Dottrel is in very great request by the manufacturers of artificial flies for fishing, and accounts for their being pursued and killed in such numbers: and it is probably owing to this circumstance that they are every year becoming more and more scarce in the vicinity of Keswick. We regret to add that not a single bird has been seen there this summer, which may partly be attributed to the numbers killed last year, and has in all likelihood caused them to resort to some more sequestred place. The eggs of the Dottrel, we believe, still remain undescribed, which is somewhat extraordinary, considering that they constantly breed in the mountainous districts of Yorkshire,

Yorkshire, Westmorland, Cumberland, and some parts of Scotland. Dr. Latham, it is true, in the last edition of his General History of Birds, has given some account of the nest of this species, the time and period of their incubation, and the numbers of their eggs, but does not describe them under these circumstances. We trust the following description, although now written upwards of forty-four years ago, will not be altogether uninteresting to our ornithological readers.

"Some time last summer a nest of the Dottrel was found on Skiddaw; the old one was killed and the eggs brought away, which were three or four in number. I saw three of them; they are somewhat larger than a magpie's egg, the ground is a dirty clay colour marked with large irregular black spots. February 14, 1785*."

Common Tern.—This species does not visit Solway Frith in any great numbers, and for some years past has been much less numerous than usual. It is there called by the fishermen and others, Jerky, Pickman, &c. The Lesser Tern (*S. minuta*) rarely visits the Frith, and Allonby is the nearest place we have lately received it from.

The spring of the present year was one of the most backward that has occurred in this neighbourhood for very many years. During the whole of April and the beginning of May the thermometer was frequently below the freezing point, the surrounding mountains more or less covered with snow, and the weather in general gloomy, wet, and extremely cold.

It was not until the 6th of May that the white-thorn (*Cratægus oxyacantha*) in the hedges began to exhibit any very evident symptoms of verdure, and the woods were almost entirely destitute of their foliage for some time after; in short, the winter might be said to have been protracted, with little or no exaggeration, until nearly the middle of May.

We have been led to make these remarks, from its being generally admitted that the early or late appearance of the summer birds of passage depends entirely upon the state and temperature of the weather, &c.; yet it will be perceived that the Swallow and Grasshopper Warbler arrived unusually early, and, with the exception of the Goatsucker, Whinchat, and Wood Wren, all the others about the time they have arrived for the last two years. A violent storm from the north-east, which commenced on the 28th of April, and which continued, although somewhat abated, for several successive days, will account in some measure for the delay in the appearance of these three species, it having begun about the time they commonly

* Dr. Heysham's MSS.

monly made their appearance in this vicinity. Much might be said upon this very interesting subject, and it is probable we may recur to it at some future opportunity.

Carlisle, August 28, 1829.

XLII. *On the Oxides of Manganese; in a Letter addressed to* Edward Turner, *M.D. F.R.S. E. and Professor of Chemistry in the University of London. By* R. Phillips, *F.R.S. L. & E. &c.*

My dear Sir, Birmingham, Sept. 1, 1829.

I READILY subscribe to the opinion expressed in your letter to me, that "the temperate discussion of scientific subjects rarely fails to advance the interests of science;" and I trust we shall also eventually agree that our correspondence respecting the oxides of manganese, will form no exception to the observation.

In the first place, I am anxious to explain my reasons for having doubted the accuracy of your analysis of the Ihlefeld manganite. Some time after I had given you a specimen of the Warwickshire ore of manganese, you informed me by letter that it was manganite. Regarding this as a private communication, and more especially as I found that your analysis differed from mine, I did not feel at liberty to publish it, although I did not hesitate to adopt some of the statements which it contained, as to the specific gravity and hardness of the mineral in question.

Admitting, nevertheless, the correctness of your opinion, that the Warwick oxide was similar to the Ihlefeld ore, which you had previously analysed and published an account of, and finding from repeated experiments, that the former was not deutoxide as you had stated the latter to be, I could hardly avoid the inference that you had mistaken the nature of both.

I have now, however, great pleasure in admitting the accuracy of your analysis of the Ihlefeld ore; I exposed 100 grains, of the fragments which you sent me, to a red heat in a coated glass retort, adapting to it, as in my former experiments, a vessel accurately weighed to receive the water; the weight of this was 10·4 grains, exceeding only by 0·3 of a grain the quantity which you obtained from it; this excess was probably hygrometric moisture, for I did not dry the ore previously to heating it in the retort; no oxygen gas was evolved, and as at the temperature employed I have uniformly found deutoxide of manganese remaining in the retort, I repeat what I have already stated, that I have now no doubt of the perfect exact-

ness of your analysis: allow me however to observe, that if in my experiments upon the Warwick ore, I had committed any error in ascertaining the quantity of water, as you seem to think probable from the nature of my apparatus, this near agreement with you as to the proportion yielded by the Ihlefeld manganite, will, I trust, remove all ground for suspicion on this head.

Those portions of the Warwick ore which you had selected and sent me as manganite nearly pure, were next subjected to examination; an accident however happened, which prevented me from arriving at any positive conclusion, and I had not sufficient to repeat the experiment; but still I have not the slightest doubt, that these fragments were manganite as you stated them to be, for on comparing a small remaining portion with some of the Warwick oxide, I find that a great proportion of the latter is manganite, and in many cases perfectly unmixed with any other oxide.

I have also again minutely examined the specimen of Warwick oxide, which I have stated to be a compound of 4 atoms of manganese, 7 atoms of oxygen, and 1 atom of water. And although I have varied my experiments, I have in every instance obtained fresh results, confirming my former determination.

Some time since I sent you a considerable quantity of this ore, and which I have no doubt you have mistaken for peroxide, since they greatly resemble each other in appearance and softness: you will now much oblige me by furnishing me with the results of your examination of this oxide, and I shall feel exceedingly gratified in having my experiments confirmed by so skilful an analyst as yourself. From the slight examination which I had made of the Warwick ore, when I gave you a specimen of it, I did not suspect that portions so similar in appearance, though, as you have since pointed out, so dissimilar in hardness, were really different oxides; there is now however no question, that what you examined was principally manganite, while the mineral which I analysed was the new oxide, and which, should you agree with me as to its composition, I propose to call *Varvicite*.

I am happy to find that you agree with me in some of my remarks on the red sulphate of manganese, and I feel confident that in pursuing your researches on this subject, you will find that its colour is owing to the presence of the deutoxide and not of the red oxide of manganese, as you suppose in your original memoir. I have now kept different portions of this solution exposed to air and light, and also excluded from both for about ten months; the colour has not in any instance suffered

fered much loss of intensity, but in all cases a little black oxide has been deposited: this I have no doubt is peroxide, but the quantity is too small to admit of its being examined.

I remain, my dear Sir, yours faithfully,

R. Phillips.

Annexed is Dr. Turner's answer to the foregoing letter.

My dear Sir, London, Sept. 21, 1829.

I have examined the specimen of manganese referred to by you in your letter of the 1st of September, and find it quite different from that which you formerly gave me. I agree with you in considering it a definite compound, and readily admit it to be quite distinct both from the peroxide and manganite. In its highly crystalline lamellated structure, as also in its lustre, it nearly resembles manganite; whereas in hardness and in the colour of its powder, it is very similar to the peroxide. Its specific gravity, according to my observation, is 4·531. At a white heat it lost 13.11 per cent., of which 5·725 per cent. were water. I am satisfied, therefore, that the discordance in our first set of experiments arose solely from your accidentally sending me, as a specimen of your new oxide, a mineral which was really different. That mixed oxide must I apprehend have contained varvicite, as well as the two other oxides.

The satisfaction which I feel in so agreeably terminating our discussion on the Warwick ore, is not a little increased by the circumstance of your having confirmed the accuracy of my analysis of manganite. The only point of difference between us now unsettled, respects the coloured solution of manganese in sulphuric acid. I have not yet had leisure to examine this subject fully; but as the conditions under which our experiments were made are somewhat different, it is likely we may both eventually be found correct.

I remain, my dear Sir, yours sincerely,

Edward Turner.

To R. Phillips, Esq.

XLIII. *On the Discovery of Iodine and Bromine in the Mineral Waters of England. By* J. Murray, *Esq., F.S.A., F.L.S., &c.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

Dr. Daubeny has, in your last Number, announced the discovery of iodine and bromine in some of the mineral waters of England, *inter alia* those of Cheltenham and

 Gloucester.

Gloucester. I had long ago discovered iodine in both, the quantity in the former being minute, and in the latter important. I also found the muriate of ammonia in both: but lest Dr. Daubeny should treat a mere assertion as a posthumous claim, my evidence will be found in the announcement enrolled in the columns of the "Gloucester Journal" and other newspapers; and this is also recorded in the second edition of my "Manual of Experiments illustrative of Chemical Science*." At the period in question, bromine had not been discovered; but since that time I discovered both iodine and bromine in the brine springs at Ingestrie, and the fact was communicated to Earl Talbot six months ago. I also found bromine in a portion of water which I brought from the *Salines* at Bex in Switzerland; the presence of iodine in them had been previously announced.

In the former case I might also have referred to Dr. Baron of Gloucester, and others; but I trust I have said quite enough to substantiate my claims to priority, and may merely now add, that I repeated a number of interesting experiments some months ago on the Breakwater in Plymouth Sound, which seemed to me an eligible station for the eudiometrical examination of the incumbent marine atmosphere; and it may be here merely necessary to mention that I detected the presence of carbonic acid gas, muriates; and received distinct evidence of both iodine and bromine.

I am, Gentlemen, yours, &c.

8th September, 1829. J. MURRAY.

XLIV. *On Measuring the Force of Pressure. By* B. BEVAN, *Esq.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

TO the practical mechanic, it is often desirable to ascertain the actual pressure produced by various machines and instruments, and it is often desirable to do this in spaces too small to admit the ordinary machines for measuring the force of pressure; such, for instance, as powerful screw and hydraulic presses, and other machines of that nature. To the screw, in all its modifications, there always belongs a very considerable portion of friction at present not well determined:—the proportion of friction to the gross pressure in the hydraulic press has not been satisfactorily ascertained.

Having lately discovered a mode of measuring the actual

* Published by Messrs. Longman and Co.

pressure,

pressure, in small spaces, with considerable accuracy, I take the opportunity of offering it to the public through your useful publication.

If we take a leaden bullet of any determinate diameter, and expose it to pressure between plates of harder metal, made to approach each other in a parallel position, the bullet will be compressed or flattened on two opposite sides in an equal degree; provided the lead is pure, the degree of compression will indicate the amount of pressure. With a graduated press of the lever kind, it will be easy to form a scale of pressure corresponding to the different degrees of compression, until the ball is reduced to a flat circular plate, of about one-fifth of an inch in thickness; and it will be found that an ordinary bullet of about five-eighths of an inch diameter will require a pressure of near 4000 pounds to effect this degree of flattening. Suppose, therefore, we wish to measure an actual pressure supposed to be nearly twenty tons, we have only occasion to place ten or twelve of these balls at a proper distance asunder, so as not to be in contact when expanded, and then to measure by good callipers, or other suitable means, the compression of each ball, either by its thickness or diameter, and afterwards add into one sum the particular pressure due to each ball, from the scale first made by using the lever press before mentioned.

By this mode I have ascertained the amount of friction of an iron screw press, with rectangular threads, to be from three-fourths to four-fifths of the power applied; or the actual pressure has not exceeded four or five tons, when the calculated pressure, if there had been no friction, would have been twenty tons.

The larger the ball, the greater will be the pressure necessary to reduce it to a given thickness. An ordinary leaden shot of one-eighth of an inch diameter will require nearly 100 pounds to compress it to a flat plate.

By using a ball of five-eighths of an inch diameter, I have found the actual pressure of the common bench vice to be about two tons; when under the same force, if there had been no friction, the pressure would have been eight tons.

In the practical application of these balls, it will be convenient to make a small impression upon them with a hammer, before they are placed between the plates, to prevent them from rolling out of their proper position; this operation will not be found to interfere with the result, as it is the ultimate compression only that is sought, and which is not affected by that of a smaller degree before impressed. This property will also be found very convenient; for we may use the same substance

substance several times, by taking care that each succeeding pressure exceeds that of the preceding, in the same manner as Wedgewood's pyrometers are used to measure any greater degree of heat than what they have been formerly exposed to.

It may be observed, that the application of these leaden balls to determine the actual pressure, will not interfere with the regular operation of a press, as the articles under pressure may be in the press at the same time the balls are used, which of course must be placed between separate plates.

I am, Gentlemen, yours, &c.

Leighton Bussard, 14th Sept. 1829. B. BEVAN.

XLV. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. CHILDREN, *F.R.S. L. & E. F.L.S. &c.*

[Continued from page 199.]

Genus 75. CUCULLIA, *Ochs., Treitsch.*

CUCULLIA, Schrank. (Curtis, Stephens, Duponchel.)

TRIBONOPHORÆ, Hübner.

Legs, hairy: *tarsi* five-jointed, with a row of spines on each side beneath.—*Wings superior* deflexed, narrow, lanceolate: *inferior* rather small.—*Antennæ* very long, and setaceous in both sexes.—*Palpi* with the last joint very short, cylindrical, truncated and nearly naked; entire length less than that of the head.—*Maxillæ* nearly twice as long as the antennæ.—*Head* rather small, obtuse.—*Thorax* with an elevated crest, forming anteriorly a sort of hood, which partially covers the head*.—*Abdomen* long, often with dorsal tufts, and sometimes with a long pointed, or divided apex.—*Larva* with 16 feet, smooth, moniliform.—*Pupa* with the case inclosing the maxillæ, feet and wings elongated into a sort of sheath distinct from the abdomen †.

Species.	Icon.
1. Cuc. *Spectabilis*, Hüb. ...	Hüb. Noct. tab. 120. f. 557. (mas.)
2.—*Gnaphalii*, Hüb.	Hüb. Noct. tab. 126. f. 582. (mas.) 583. (fœm.)
3.—*Abrotani*, Fab.	Ernst, VI. pl. ccxlv. f. 362.
4.—*Absinthii*, Linn.........	Ernst, VI. pl. ccxlv. f. 361.
5.—*Artemisiæ*, Fab.........	Ernst, VI. pl. ccxliv. f. 360.

* Hence the name of the genus from *Cucullus* (*a hood*).

† Characters chiefly from Curtis and Duponchel.

6. Cuc.

Species.	Icon.
6. Cuc. *Argentina*, Fab......	Hüb. Noct. tab. 119. f. 553. (fœm.)
7.—*Lactea*, Fab.	Hüb. Noct. tab. 95. f. 448. (mas.)
8.—*Tanaceti*, Fab..........	Ernst, VI. pl. ccxlvii. f. 366.
9.—*Dracunculi*, Hüb.	Hüb. Noct. tab. 127. f. 586. (mas.)
10.—*Umbratica*, Linn........	Ernst, VI. pl. ccxlviii. f. 369. a—d.
11.—*Lactucæ*, Fab...........	Ernst, VI. pl. ccxlviii. f. 368.
12.—*Chamomillæ*, Fab.......	Hüb. Noct. tab. 54. f. 261. (mas.)
13.—*Chrysanthemi*, Hüb. ...	Hüb. Noct. tab. 149. f. 686. (fœm.) 687. (mas.)
14.—*Lucifuga*, Hüb..........	Hüb. Noct. tab. 54. f. 262. (mas.)
• 15.—*Asteris*, Fab.	Ernst, VI. pl. ccxlvi. f. 364. a. b. Curtis, Brit. Ent. vol. i. pl. 45. Imago et Larva.
16.—*Thapsiphaga*, Treitsch.*	— — —
17.—*Blattariæ*, Esper.	Esper. Schm. IV. Th. tab. cliv. Noct. 75. f. 4.
18.—*Verbasci*, Linn..........	Ernst, VI. pl. ccxlvi. f. 364. a–d. g. h.
19.—*Scrophulariæ*, Hüb.....	Ernst, VI. pl. ccxlvi. f. 363.

Genus 76. PLUSIA, *Ochs.*, *Treitsch.*

(Latreille, Duponchel, Stephens.)

PLUSIÆ, Hübner.

Wings, deflexed, superior and posterior angles of the *upper*, very acute and somewhat curved.—*Antennæ* filiform in both sexes.—*Palpi* curved upwards above the head, but very little surpassing it.—*Thorax* with two tufts of hair at the base.—*Abdomen*, crested with tufts of hair on the first three or four segments.—*Larva* with 12 feet, the body sprinkled with a few hairs, the head small and the three first segments more slender than the rest.—*Pupa* with the case inclosing the maxillæ, feet and wings elongated into a sheath adhering to the abdomen †.

Obs. Most of the species of this genus are remarkable for the metallic splendour of their superior wings ‡, which reflect a golden or silvery brilliancy, sometimes from larger or smaller bands or plates, sometimes from slender lines or small spots more or less resembling letters or accents.

Treitschke has divided this genus into five families, according to the markings of the superior wings. Duponchel has adopted four divisions of it, on similar grounds, as follows:

* Cuc. alis anticis medio ex albido cinereis, marginibus fuscescentibus, serie duplici punctorum nigrorum.—*Ochs. Treitsch.* v. *pars* iii. p. 120.

† Characters chiefly from Duponchel, *Lep. de France*, *tom.* vii. *part* ii. p. 5.

‡ Hence the name of the genus, from πλουσιος (dives.)

1st Di-

1st Division. No metallic spots on the superior wings.—Pl. *illustris—modesta—consona—ærea.*

2nd. Upper wings with larger or smaller metallic spots of undefined forms. — Pl. *orichalcea—chrysitis—aurifera—bractea—æmula—festucæ.*

3rd. Upper wings with small metallic spots in the form of letters or accents, and the lower wings gray.—Pl. *mya—chalsytis—iota—gamma—ni—interrogationis—accentifera—circumflexa.*

4th. Upper wings as in the third division, but the lower dull yellow, with dark margins.—Pl. *ain—microgramma—divergens.*

The species, *triplasia*, *asclepiadis*, *consona*, *modesta*, and *illustris*, were originally arranged by Ochsenheimer in a separate genus, which he called *Abrostola*. He, however, as his successor informs us, after the publication of the *Systema Glossatorum Europæ*, in his 4th volume, united them to his *Plusiæ*, in which arrangement he has been followed by M. Treitschke. Stephens (Syst. Cat. ii. p. 104.) has revived the genus *Abrostola* (also adopted by Samouelle, Compend. p. 252) for the reception of the British species, *triplasia*, *asclepiadis*, *urticæ ?* and *illustris*.

	Species.	Icon.
Fam. A.		
	1. Pl. *Amethystina*, Hüb....	Hüb. Noct. tab. 130. f. 597. (mas.)
Fam. B.		598. (fœm.)
	2. Pl. *Triplasia*, Linn.	Ernst, VIII. pl. cccxxxii. f. 578.
	3.—*Asclepiadis*, Fab.	Hüb. Noct. tab. 55. f. 268. (fœm.) tab. 137. f. 626. (mas.)
	4.—*Urticæ*, Hüb	Hüb. Noct. tab. 137. f. 625. (mas.)
Fam. C.		
	5. Pl. *Celsia*, Linn	Ernst, Suppl. pl. viii. f. 262. a—d.
Fam. D.		
	6. Pl. *Consona*, Fab..	Hüb. Noct. tab. 56. f. 273. (fœm.)
	7.—*Modesta*, Hüb.	Hüb. Noct. tab. 76. f. 354. (fœm.)
	8.—*Illustris*, Fab	Ernst, VIII. pl. cccxxxiii. f. 583.
Fam. E.		
	9. Pl. *Deaurata*, Esper.*...	Hüb. Noct. tab. 59. f. 189.
	10.—*Moneta*, Fab.*	Ernst, VIII. pl. cccxxxiv. f. 584.
	11.—*Concha*, Fab*	Ernst, VIII. pl. cccxxxv. f. 587.
	12.—*Chalsytis*, Hüb.	Ernst, VIII. pl. cccxxxiv. f. 586.
	13.—*Festucæ*, Linn.	Ernst, VIII. pl. cccxxxiv. f. 585.

14. Pl. *Auri-*

* Chrysoptera, Latr.—Duponch.—" *Palpi* very long, curved above the head and very much surpassing it.—*Antennæ* filiform in both sexes.—*Thorax* with two tufts of hair at the base.—*Superior* and *posterior angles* of the *upper wings* very acute, and slightly curved. *Abdomen* crested on the

Species.	Icon.
14. Pl. *Aurifera*, Hüb.	Hüb. Noct. tab. 98. f. 463. (mas.)
15.—*Chrysitis*, Linn.	Ernst, VIII. pl. cccxxxv. f. 588.
16.—*Orichalcea*, Fab.	Ernst, VIII. pl. cccxxxvi. f. 589.
17.—*Bractea*, Fab.	Ernst, VIII. pl. cccxxxvi. f. 590.
18.—*Æmula*, Hüb.	Hüb. Noct. tab. 57. f. 280. (mas.)
19.—*Circumflexa*, Linn.	Ernst, VIII. pl. cccxxxvi. f. 591.
20.—*Iota*, Linn.	Ernst, VIII. pl. cccxxxvii. f. 592.
21.—*Gamma*, Linn.	Ernst, VIII. pl. cccxxxviii. f. 594.
22.—*Ni*, Hüb.	Ernst, VIII. pl. cccxxxviii. f. 595.
23.—*Interrogationis*, Linn.	Ernst, VIII. pl. cccxxxvii. f. 593.
24.—*Ain*, Hüb.	Ernst, VIII. pl. cccxxxix. f. 596.
25.—*Divergens*, Fab.	Ernst, VIII. pl. cccxxxix. f. 597.
26.—*Devergens*, Hüb.	Hüb. Noct. tab. 107. f. 500. (mas.) 501. (fœm.)
27.—*Microgamma*, Hüb.	Hüb. Noct. tab. 151. f. 698. (fœm.) 699. (mas.)

Genus 77. ANARTA, *Ochs.*, *Treitsch.*

(Curtis, Stephens.)

Legs, anterior the shortest, the *tibiæ* with a flat strong spine on the internal side, middle and posterior tibiæ very hairy towards the base, terminated by spurs, the latter having a pair also above the apex: *tarsi* very long, the basal joint nearly as long as the tibiæ.—*Wings* deflexed; superior lanceolate, inferior small.—*Antennæ* alike in both sexes, rather long, slender, setaceous, covered with scales above, pubescent beneath, basal joint robust, ovate.—*Palpi* extending a little beyond the head, very hairy.—*Maxillæ* as long as the antennæ, furnished with tentacula towards the apex.—*Head* very small: *eyes* small, pubescent.— *Thorax* not crested, covered with hairy scales.—*Abdomen* short, robust, ciliated on the sides and at the apex.—*Larva* naked, with 16 feet*.

The individuals of this genus are small, and fly by day, revelling in the sunshine.

the three or four anterior segments.—*Larva* with 12 feet; *head* small; three first segments of the body smaller than the rest, the latter with angular tubercles above. *Pupa* with the case of the maxillæ, feet and wings elongated into a sheath, adhering to the abdomen."

The individuals (only three) of this genus differ from the true Plusiæ, principally in the greater development of their palpi; they are ornamented with metallic colours, even more brilliant than those of the latter, and the larvæ of the two genera differ by those of the Chrysoptera having the nine posterior segments of the body surmounted by angular elevations.—*Duponchel*, *Lep. de France*, *tom.* vii. *part.* ii. p. 58.

* Characters from Curtis, *Brit. Ent.* iii. pl. 145.

Species.	Icon.
1. An. *Myrtilli*, Linn.........	Ernst, VII. pl. cclxxiii. f. 437. Curtis, Brit. Ent. III. pl. 145. Larva et Imago.
2.—*Cordigera*, Thunb......	Hüb. Noct. tab. 21. f. 99. (fœm.) tab. 147. f. 675. (mas.)
3.—*Melaleuca*, Thunb......	Hüb. Noct. tab. 77. f. 357. (fœm.)
4.—*Vidua*, Hüb.............	Hüb. Noct. tab. 86. f. 403. (fœm.) tab. 141. f. 644. 645. (mas.)
5.—*Funebris*, Hüb.	Hüb. Noct. tab. 92. f. 433. (fœm.)
6.—*Rupicola*, Wien. Verz.	Hüb. Noct. tab. 64. f. 317. (fœm.)
7.—*Heliaca*, Hüb...........	Ernst, VIII. pl. cccxlii. f. 606.

Genus 78. HELIOTHIS, *Ochs.*, *Treitsch.* (Stephens.)

HELIOTHENTES, Hübner.

Wings, anterior broad, generally of lively colours; posterior whitish, or light-coloured with broad, dark margins.—*Antennæ* long, setaceous.—*Abdomen* slender, tapering.—*Larva* slender, tapering towards the head and tail; *head* speckled; *body* marked with dark-coloured dots on the sides, and variegated, longitudinal, wavy lines.—*Metamorphosis* subterranean.

Species.	Icon.
1. Hel. *Cardui*, Hüb.........	Hüb. Noct. tab. 64. f. 313. (fœm.)
2.—*Ononis*, Fab.	Hüb. Noct. tab. 63. f. 312. (fœm.)
3.—*Dispacea*, Linn..........	Ernst, VIII. pl. cccxvi. f. 553.
4.—*Scutosa*, Fab.............	Ernst, VIII. pl. cccxv. f. 552.
5.—*Pettigera*, Hüb.........	Ernst, VIII. pl. cccxvi. f. 555.
6.—*Armigera*, Hüb.........	Hüb. Noct. tab. 79. f. 370. (fœm.)
7.—*Marginata*, Fab.........	Ernst, VII. pl. cclxxxviii. f. 480.
8.—*Purpurites*, Hüb.	Ernst, VII. pl. cclxxxviii. f. 481.

Genus 79. ACONTIA, *Ochs.*, *Treitsch.* (Curtis, Stephens.)

Legs, anterior with an internal spine on the tibiæ; posterior pair long, the tibiæ spurred at and above the apex: *tarsi* 5-jointed, basal joint the longest: claws bifid.—*Wings* rhomboidal or sublanceolate; cilia rather long.—*Antennæ* simple, slender and setaceous, inserted on the crown of the head close to the eyes, covered with scales above, very pubescent beneath.—*Palpi* curved upward, clothed with close, short scales.—*Maxillæ* slender, spiral, as long as the antennæ, ciliated on the outside at the apex.—*Head* broad: *eyes* rather large.—*Thorax* obovate, clothed with compact, depressed scales.—*Abdomen* rather slender, tufted and obtuse

tuse in the males, subconical in the females.—*Larva* attenuated to both ends; with 12 feet*.

Species.	Icon.
1. Acon. *Malvæ*, Hüb.*	Hüb. Noct. tab. 77. f. 358. (fœm.)
2.—*Aprica*, Hüb	Hüb. Noct. tab. 80. f. 371. (fœm.)
3.—*Cerinthæ*†.	
4.—*Caloris*, Hüb	Hüb. Noct. tab. 80. f. 372. (fœm.)
5.—*Titania*, Esper	Esper, Schm. IV. Th. tab. cxc. Noct. iii. f. 2.
6.—*Solaris*, Hüb	Hüb. Noct. tab. 62. f. 307. (mas.) 308. (fœm.)
7.—*Luctuosa*, Hüb	Hüb. Noct. tab. 62. f. 305. (mas.) 306. (fœm.)

Genus 80. ERASTRIA, *Ochs.*, *Treitsch.* (Curtis, Stephens.)

Legs, anterior *tibiæ* with a small spine on the internal side, middle and posterior pairs armed at the apex, and the latter, towards the middle also with spines of unequal length: *tarsi* rather stout, 5-jointed; basal joint the longest: *claws* simple.—*Wings* nearly horizontal when at rest, forming a triangle; *superior* with the anterior angle somewhat acute; *inferior* rather large, rounded.—*Antennæ* alike in both sexes, inserted close to the eyes on the crown of the head, rather short, setaceous, scaly above, hairy beneath; basal joint elongate, robust.—*Palpi* porrected obliquely beyond the head, remote, rather slender, covered with scales, slightly curved.—*Head* short, covered with depressed scales.—*Thorax* not crested, covered with short scales.—*Abdomen* slightly tufted at the apex.—*Larva* half looper, with 10 feet‡.

Species.	Icon.
1. Erast. *Sulphurea*, Hüb.	Ernst, VIII. pl. cccxxxix. f. 598.
2.—*Unca*, Hüb	Ernst, VIII. pl. cccxxxiii. f. 581.
3.—*Argentula*, Borkh	Hüb. Noct. tab. 60. f. 292. (fœm.)
4.—*Fuscula*, Wien. Verz.	Ernst, VI. pl. ccxxiv. f. 319.
5.—*Quieta*, Hüb	Hüb. Noct. tab. 103. f. 485. (fœm.)
6.—*Atratula*, Hüb	Hüb. Noct. tab. 60. f. 296. (fœm.)
7.—*Candidula*, Hüb.	Hüb. Noct. tab. 60. f. 295. (fœm.)
8.—*Venustula*, Hüb.	Hüb. Noct. tab. 60. f. 294. (mas.)
9.—*Minuta*, Hüb.	Hüb. Noct. tab. 96. f. 451. (fœm.)

* Characters from Curtis. *Brit. Ent.* vi. pl. 276.

† Acon. alis anticis albis, fasciis tribus fusco cæruleoque marmoratis, intermedia magis obsoleta; posticis albis.—*Ochs. Treitsch.* v. *pars* iii. p. 240.

‡ Characters chiefly from Curtis. *Brit. Ent.* iii. pl. 140.

 10. Erast.

Species.	Icon.
10. Erast. *Paula*, Hüb........	Hüb. Noct. tab. 96. f. 452. (mas.) Pyr. tab. 6. f. 38. (fœm.)
11.—*Parva*, Hüb.............	Hüb. Noct. tab. 77. f. 356. (fœm.)
12.—*Ostrina*, Hüb...........	Hüb. Noct. tab. 85. f. 399. (fœm.) tab. 142. f. 648. (mas.) Curtis, Brit. Ent. III. pl. 140.
13.—*Cymbalariæ*, Hüb......	Hüb. Noct. tab. 92. f. 432. (fœm.)

Genus 81. ANTHOPHILA*, *Ochs.*, *Treitsch.*

ANTHOPHILÆ, Hübner. (ACOSMETA, Steph.†
PHYTOMETRA, Steph. NOCTUA., God. Duponch.)

Legs, posterior elongated.—*Wings*, *superior* subtriangular, anterior angle acute, generally without the usual orbicular or reniform markings; *inferior* rounded, with broad fringes.—*Antennæ* nearly filiform, faintly pectinated.—*Head* smooth.—*Body* small.—*Larva* unknown.

The insects of this genus fly by day, and enjoy the sunshine.

Species.	Icon.
1. Ant. *Ænea*, Hüb.‡.........	Hüb. Noct. tab. 75. f. 350. (fœm.)
2.—*Purpurina*, Fab........	Ernst, VIII. pl. cccx. f. 539.
3.—*Communimacula*, Fab...	Ernst, VII. pl. ccxciii. f. 494.
4.—*Flavida*, Hüb...........	Hüb. Noct. tab. 96. f. 453. (fœm.)
5.—*Vespertina*, Treitsch...	Hüb. Pyr. tab. 24. f. 159. (mas.)
6.—*Glarea*, Treitsch.§	
7.—*Amœna*, Hüb...........	Hüb. Noct. tab. 61. f. 300. (fœm.)
8.—*Inamœna*, Hüb.........	Hüb. Noct. tab. 61. f. 301. (mas.) 302. (fœm.)
9.—*Caliginosa*, Hüb.‖......	Hüb. Noct. tab. 100. f. 474. (mas.)

Genus 82. OPHIUSA, *Ochs.*, *Treitsch.*

ASCALEPHÆ, Hübner. (OPHIUSA, Steph.)

Wings, *superior* broad, subtriangular, anterior angle acute; *inferior* rounded, margins deeply fringed.—*Antennæ* long, filiform, very faintly pectinated, except in the male of the last species.—*Abdomen* long, slender.—*Larva* with 12 feet, naked, slender: in their motion they resemble the larvæ of the Geometridæ.—*Pupa* folliculated; *metamorphosis* on the ground, or subterranean.

The insects of this genus fly chiefly by night, but also, occasionally, in the day-time.

* ἄνθος flos, φιλέω amo. † Syst. Cat. ii. 110. Gen. 151 and 152.

‡ PHYTOMETRA, Steph. *l. c. supra*.

§ Ant. alis anticis albis, viridi flavo undulatis.—*Ochs. Treitsch.* v. *pars* iii. p. 282. ‖ ACOSMETIA, Steph. *l. c. supra*.

1. Opt.

Species.	Icon.
1. Oph. *Lusoria*, Fab.	Ernst, VIII. pl. cccxli. f. 600.
2.—*Ludicra*, Hüb.	Hüb. Noct. tab. 65. f. 319. (fœm.)
3.—*Viciæ*, Hüb.	Hüb. Noct. tab. 145. f. 664. 665. (fœm.) tab. 146. f. 671. 672. (mas.) 673. (fœm.)
4.—*Craccæ*, Fab.	Ernst, VIII. pl. cccxli. f. 601.
5.—*Pastinum*, Treitsch.*.	— — —
6.—*Limosa*, Treitsch.	Ernst, VIII. pl. cccxli. f. 602. a.
7.—*Tirrhæa*, Fab.	Hüb. Noct. tab. 66. f. 321. (fœm.)
8.—*Lunaris*, Fab.	Ernst, VIII. pl. cccxl. f. 599.
9.—*Illunaris*, Hüb.	Hüb. Noct. tab. 122. f. 565. (fœm.) tab. 124. f. 574. (mas.)
10.—*Punctularis*, Hüb. . . .	Hüb. Noct. tab. 78. f. 364. (fœm.)
11.—*Algira*, Linn.	Ernst, VIII. pl. cccvii. f. 531.
12.—*Geometrica*, Fab. . . .	Hüb. Noct. tab. 66. f. 324. (fœm.)
13.—*Cingularis*, Hüb. . . .	Hüb. Noct. tab. 76. f. 352. (fœm.)
14.—*Jucunda*, Hüb.	Hüb. Noct. tab. 103. f. 436. (mas.) tab. 105. f. 492. (fœm.)
15.—*Regularis*, Hüb.	Hüb. Noct. tab. 128. f. 588. (fœm.)
16.—*Irregularis*, Hüb. . . .	Hüb. Noct. tab. 78. f. 361. (fœm.)
17.—*Scapulosa*, Hüb.† . . .	Hüb. Noct. tab. 77. f. 360. (mas.) tab. 121. f. 561. (fœm.)

Genus 83. CATEPHIA‡, *Ochs.*, *Treitsch.*

(Catephia, Stephens, Boisduval.)

Wings, *superior* dark coloured, with sombre markings: *inferior* at the base light coloured, with a broad dark margin.—*Antennæ* setaceous, slightly pectinated.—*Abdomen* dark coloured, with tufts of hairs on the posterior segments.

Species.	Icon.
1. Cat. *Leucomelas*, Hüb. . .	Ernst, VIII. pl. cccxvii. f. 557.
2.—*Alchymista*, Hüb. . . .	Ernst, VIII. pl. cccxvii. f. 556.

* Oph. alis anticis glaucescentibus, obsoletè fusco fasciatis, maculâ reniformi punctisque nigris.—*Ochs. Treitsch.* v. *pars* iii. p. 297.

† Cerocala, Boisduval. *Europ. Lepid. Ind. Meth.*—Duponchel remarks of this species, that it is quite anomalous, for from the form of its palpi, the last joint of which is slender and very long, and from the length of the maxillæ, it should belong to the genus Erebus Latr.; but its slender body and the very strongly pectinated, or rather plumose antennæ of the male, denote its place to be with the Phalænidæ. Until the larva, however, which as yet is unknown, shall have been discovered, its true situation must remain doubtful. Latreille (who makes it an Erebus) is evidently of the same opinion as Boisduval, that it may be separated from all the hitherto-known genera, since he says, "Les males de quelques espèces" (of his genus Erebus) "ont les antennes pectinées, *et pourraient constituer un sous-genre propre.*"

‡ κατηφεια luctus.

Genus

Genus 84. CATOCALA*, *Ochs.*, *Treitsch.*

CATOCALA, Schrank. (Curtis, Stephens, Boisduval.)

BLEPHARA, Hübner.

Legs long, anterior the shortest; *anterior tibiæ* short, with a compressed broad spine on the inner side; anterior tarsi much longer than the tibiæ.—*Wings* ample, slightly deflexed; *superior* subtrigonate; cilia long, indented.—*Antennæ* alike in both sexes, long, slender, setaceous.—*Palpi* porrected obliquely, triarticulate, densely clothed with long scales.—*Maxillæ* as long as the antennæ, ciliated at the apex.—*Head* rather small.—*Thorax* large.—*Abdomen* robust, cylindrical, attenuated, tufted on the back at the base and tail.—*Larva* with 16 feet.—*Pupa* inclosed in a large cocoon formed between some leaves†.

Species.	Icon.
1. Catoc. *Fraxini*, Linn....	Ernst, VIII. pl. cccxx. et cccxxi. f. 563. a—i.
2.—*Elocata*, Esper......	Ernst, VIII. pl. cccxxii. et cccxxiii. f. 564.
3.—*Nupta*, Linn.	Ernst, VIII. pl. cccxxiii. f. 565.
4.—*Dilecta*, Hüb.......	Ernst, VIII. pl. cccxxv. f. 568. g. h.
5.—*Sponsa*, Linn.......	Ernst, VIII. pl. cccxxv. f. 568. a—e.
6.—*Conjuncta*, Esper....	Ernst, VIII. pl. cccxxvii. f. a—d.
7.—*Promissa*, Fab......	Ernst, VIII. pl. cccxxvi. f. 569.
8.—*Pacta*, Linn.	Ernst, VIII. pl. cccxxiv. f. 567.
9.—*Electa*, Hüb.......	Ernst, VIII. pl. cccxxiv. f. 566.
10.—*Puerpera*, Giorna.‡ ..	Hüb. Noct. tab. 92. f. 435. (mas.) tab. 129. f. 594. (fœm.)
11.—*Neonympha*, Hüb....	Hüb. Noct. tab. 95. f. 450. (mas.)
12.—*Nymphæa*, Hüb.....	Ernst, VIII. pl. cccxxviii. f. 572.
13.—*Conversa*, Esper. ..	Ernst, VIII. pl. cccxxvii. et cccxxviii. f. 571.
14.—*Agamos*, Hüb.	Hüb. Noct. tab. 112. f. 525. (mas.)
15.—*Paranympha*, Linn...	Ernst, VIII. pl. cccxxix. f. 573.
16.—*Nymphagoga*, Hüb...	Ernst, VIII. pl. cccxxx. f. 575.
17.—*Hymenæa*, Fab.	Ernst, VIII. pl. cccxxix. f. 574.

Genus 85. BREPHOS, *Ochs.*, *Treitsch.*

BREPHA, Hübner. (Curtis, Stephens.)

Legs, anterior rather short; *anterior tibiæ* with a spine on the inside: *tarsi* five-jointed.—*Wings* rather narrow, horizontal

* κατω subtus, καλος pulcher.
† Characters from Curtis. *Brit. Ent.* v. pl. 217.
‡ Calendario Entomologico. Torino, 1791.

when

when at rest.—*Antennæ* pectinated in the males; filiform, slender and clothed with long scales in the females.—*Palpi* with three joints, covered with long spreading hairs.—*Maxillæ* very long and tapering, with a dilated membranous edge, and tentacula towards the apex.—*Abdomen* slender. —*Larva* with 16 feet*.

Species.	Icon.
1. Breph. *Parthenias*, Linn.	Ernst, VIII. pl. cccxxxi. f. 577. a. b. e—h.
2.—*Notha*, Hüb.	Ernst, VIII. pl. cccxxxi. f. 577. c. d. k. i. Curt. Brit. Ent. III. pl. 121. ♂ et ♀.
3.—*Puella*, Esper.	Ernst, VIII. pl. cccxxx. f. 576.

Genus 86. EUCLIDIA, *Ochs.*, *Treitsch.*

EUCLIDIÆ, Hübner. (EUCLIDIA, Stephens.)

Wings, anterior generally marked with transverse bars, and figures resembling mathematical symbols; *posterior* usually with blackish maculæ, and bars, on a yellow ground.—*Antennæ* short, filiform, slightly pectinated in the males.—*Abdomen* slender, rather elongated.—*Larva* slender, with 12 feet. — *Pupa* folliculated; *metamorphosis* not subterranean.

Species.	Icon.
1. Eucl. *Monogramma*, Hüb.	Hüb. Noct. tab. 76. f. 353. (mas.)
2.—*Glyphica*, Linn.	Ernst, VIII. pl. cccxlii. f. 604.
3.—*Triquetra*, Fab.	Ernst, VIII. pl. cccxlii. f. 605.
4.—*Mi*, Linn.	Ernst, VIII. pl. cccxli. f. 603.

Genus 87. PLATYPTERYX†, *Ochs.*, *Treitsch.*

PLATYPTERYX, Laspeyres, Hübner, (Stephens, Duponchel.)
(DREPANA, Stephens. CILIX, Stephens.)

Wings large, nearly horizontal when at rest, the upper lying very little over the under; summit of the former, in most species, falciform.—*Antennæ* short, pectinated in the males, ciliated in the females.—*Palpi*, *inferior* very small, and nearly conical.—*Maxillæ* short, almost obsolete.—*Head* small.—*Abdomen* more or less slender.—*Larva* with 14 feet, naked, terminating in a simple truncated tail, without any feet on the last segment.—*Pupa* sprinkled with white, or gray, folliculated, and the cocoon itself inclosed in a semi-convoluted leaf‡.

* Characters from Curtis. † πλατυς latus, πτερον ala.
‡ Characters from Duponchel, *Lepidopt. de France, tom.* vii. *part.* ii. p. 73. Treitschke

Treitschke divides this genus into three families, according to the form of the upper wings.

Fam. A.—Upper wings rounded at the summit.

Fam. B.—Upper wings with the summit falciform; terminal margin entire.

Fam. C.—Upper wings with the summit falciform; terminal margin dentate.

Fam. A. Species.	Icon.
1. Plat. *Spinula*, Hüb.* . . .	Hüb. Bomb. tab. 11. f. 40. (mas.)
Fam. B.	
2. Plat. *Sicula*, Hüb.	Ernst, V. pl. ccviii. f. 277.
3.—*Curvatula*, Borkh. . . .	Ernst, V. pl. ccviii. f. 276. f. g.
4.—*Falcula*, Hüb.†	Ernst, V. pl. ccvii. f. 276. a—e.
5.—*Hamula*, Hüb.†	Ernst, V. pl. ccviii. f. 278.
6.—*Unguicula*, Hüb.	Ernst, V. pl. ccvii. f. 275.
Fam. C.	
7. Plat. *Lacertula*, Hub. . .	Ernst, V. pl. ccix. f. 279.

End of Vol. V. Part III. [To be continued.]

XLVI. *On the Determination of the Forms of the Arbitrary Functions which occur in the Integrals of Partial Differential Equations.* By J. Challis, *Fellow of the Camb. Phil. Soc.*‡

The phænomena of motion of the simplest kind, and which have hitherto been treated with the greatest success, have required the solution of differential equations between *two* variables, the integrals of which are equations between the variables of determinate form, and indicate paths of motion which are always *continuous* lines. The elliptic motion of the planets is the most remarkable instance of this kind. But another order of phænomena is presented to us, such as the motions of gases and fluids, and the small vibrations of the constituent molecules of solids, which require us to ascertain the laws of the collective motion of an infinite number of moveable points. At first sight it might appear that the motions are of that bizarre and irregular kind, that it is impossible to submit them to calculation. But nothing in nature is indeterminate; and it is perhaps not accidental that the order in complexity of the phænomena corresponds to the classification of differential equations which pure analysis would establish without reference to the natural facts. The theoretical inquiry into the motions I refer to, always con-

* Cilix, Stephens, Syst. Cat. ii. p. 157. † Drepana, Steph. l. c. p. 156.

‡ Communicated by the Author.

ducts

ducts to partial differential equations, that is, to equations between *three* or *more* variables; and theory recognises at once that these motions are not continuous,—that the path of a moveable point is not necessarily given by a determinate equation.

Little or nothing has been done in this department of science by the mathematicians of our own country, who do not seem to have considered, that we cannot hope to reduce to laws the multitude of facts that observation has accumulated, and complete our knowledge of them, without cultivating the branch of calculation which corresponds to the nature of the facts. The French academicians have shown that they are aware of the importance of the subject, by the assiduity with which they have of late attended to it. But perhaps the information we have hitherto derived from their labours, is hardly commensurate with the skilful and *recherché* modes of investigation they have made use of. And this is observable as well in those instances in which the integrations have been completely effected, as in those in which they have not been obtained under a finite form. It has appeared to me that in the former instances an important link in the chain of reasoning has been left out, and its place inadequately supplied by the invention of a species of functions (discontinuous), which, as pure analysis does not recognise them, cannot teach us any thing. This omission, I think, is to be supplied by the determination of the form of the arbitrary functions, *prior* to the application of the integrals which contain them to any specific case, and while the origins of the co-ordinates and of the time yet remain indeterminate. When the question is about the motion of the parts of fluids or solids, this form of the functions points out the mode of action of the parts on each other, which must be an action of a determinate character, and is therefore to be ascertained by a determinate form of the functions. For instance, in the discussion of the equations for incompressible fluids, contained in the Phil. Mag. and Annals for August last, a specific form of the arbitrary functions presented itself at once by the manner of performing the integration, and indicated a mode of action of the parts of the fluid on each other, which it was possible to verify by referring to a very simple matter of fact. It was shown at the same time how to arrive at the form of the arbitrary function, in an instance in which it did not immediately present itself. I proceed to employ the same method, to find the form of the arbitrary functions in the integral which determines the small motions of an elastic fluid, in which the pressure varies as the density.

 For

For simplicity I will take the case when the motion is in space of one dimension, and the fluid is solicited by no extraneous forces. Let $v =$ the velocity of the particles at a distance x from an arbitrary origin, and at a time t reckoned from an arbitrary epoch; $s =$ the condensation at the same distance, the mean density being 1, and $a^2 =$ the mean elastic force. The usual investigation leads to the equations,

$$\frac{d^2 \phi}{d t^2} = a^2 \frac{d^2 \phi}{d x^2}, \ (1) \qquad \frac{d \phi}{d t} + a^2 s = 0, \ (2) \qquad v = \frac{d \phi}{d x}, \ (3)$$

which serve to eliminate the auxiliary quantity ϕ, and to determine v and s.

The integral of equation (1) is,

$$\phi = F,(x-a\,t) + f,(x + a\,t)$$

Hence
$$v = F,(x-a\,t) + f,(x + a\,t)$$
$$a\,s = F,(x-a\,t) + f,(x + a\,t)$$

As either of the arbitrary functions will satisfy alone the equations (1), (2), (3), it will indicate a possible motion, though not the most general. It will be convenient to attend to this motion first. By taking F alone, we shall have, $v = a\,s = F\,(x - a\,t)$, showing that for a given value of t, the ordinates of the curve whose equation is $y = F\,(x - a\,t)$ will be proportional at once to the velocities and the condensations. After an interval τ the equation of this curve will become, $y = F\,(x - a.\overline{t + \tau}) = F\,(\overline{x - a\tau} - a\,t) = F\,(x' - a\,t)$. Its form must consequently be the same as before, and the values of y be identical for the same values of x' and x: but as $x = x' + a\tau$, the value of y which in the former case was at the distance x from the origin, will in the latter be at the distance $x + a\tau$. The curve, therefore, or the motion it indicates, will have been *propagated from* the origin in the time τ through $a\,\tau$. And as this is true whatever be τ, it follows that the velocity of propagation is uniform and equal to a. By considering the function f by itself, we shall have $v = - a\,s = f\,x + a\,t)$, and shall find that these equations imply a motion of propagation *towards* the origin of x and with the same velocity a. Hence in general the motion of the particles is resolvable into those which result from two simultaneous motions of propagation in opposite directions. As these propagations must have independent causes, it is allowable to suppose that in a particular case they shall be exactly alike. There will then be one point at least, where the particles have at every instant, in virtue of the two propagations, equal velocities in opposite directions. At this point, therefore, the resulting velocity is nothing, and $F\,(x - a\,t) + f\,(x + a\,t) = 0$ whatever be t. Let l be its

distance

distance from the origin of x, and let $a\,t = z$; then, whatever be z,

$$F\,(l-z) + f\,(l+z) = 0 \qquad \text{(A)}$$

Hence by Taylor's Theorem,

$$F\,(l) + f(l) - \left(F'\,(l) - f'(l)\right)z + \left(F''\,(l) + f''(l)\right)\frac{z^2}{2} - \&c. = 0$$

independently of the value of z.

$$\text{Therefore} \qquad \begin{array}{lr} F\,(l) + f\,(l) = 0 & (1) \\ F'\,(l) - f'\,(l) = 0 & (2) \\ F''\,(l) + f''\,(l) = 0 & (3) \\ \&c. & \&c. \end{array}$$

These equations are to be satisfied by a consideration of the forms of the functions F and f, so as l may have in all the same arbitrary value. Equations (1), (3), (5), &c. are plainly satisfied by making f the same as $-$ F. Hence from equation (A) $F\,(l-z) = F\,(l+z)$, and $F\,(l)$ must be a maximum or minimum. Therefore $F'\,(l) = 0$, and equation (2) is satisfied. But we must also have $F'''\,(l) = 0$, $F^{v}\,(l) = 0$, &c., that is, a function of x is to be found such, that the same value of x, which makes it a maximum or minimum, makes all its odd differential coefficients disappear. We are consequently led to a trigonometrical function, and the simplest is $\sin\,(x+c)$, which both satisfies the condition $F\,(l-z) = F\,(l+z)$, and gives for the value of l, $\frac{\pi}{2} - c$, an arbitrary quantity. Again, the only other mode in which any of the equations (1), (2), (3), &c. may be satisfied, so that l shall remain indeterminate, is by making f the same as F. By this supposition we satisfy (2), (4), &c.; and equation (A) shows, by making $z = 0$, that $F\,(l) = 0$, so that equation (1) is satisfied. At the same time $F''\,(l) = 0$, $F''''\,(l) = 0$, &c. Hence a function of x is to be found, in which the value of x, which makes it $= 0$, makes all its even differential coefficients disappear. The function $\sin\,(x+c')$ is plainly applicable; it satisfies the condition $F\,(l-z) = -F\,(l+z)$, and gives for l, $-c'$, an arbitrary quantity. In two ways, therefore, we are conducted to the same form $\sin\,(x+c)$, or, what is equivalent, $\sin x$. Also, every function which will satisfy all the above conditions must be included in the general one $\sin x + m$, $\sin 3\,x + m'\sin 5\,x +$ &c., containing an unlimited number of terms. But as this consists of terms of the same form as $\sin x$, and would indicate a motion resulting from motions of the kind indicated by $\sin x$, we have a right to conclude that the *primary* form of the function is $\sin x$. If $\lambda =$ the interval between two consecutive points at which the curve, whose ordinates are pro-

 portional

portional to the velocities and condensations, cuts the axis of x,

$v = a s = m \lambda \sin \frac{\pi}{\lambda} (x - a t)$, for the positive direction of propagation.

$v = - a s = - m \lambda \sin \frac{\pi}{\lambda} (x + a t)$, for the negative.

A similar reasoning may be applied to the equations for the motion in space of three dimensions, to those for vibrating chords, and indeed to the equations which M. Poisson, in a recent Memoir (*Acad. Scien.* tom. viii.), has obtained, by a very general consideration of the interior constitution of bodies, for the small vibrations which any homogeneous substance whatever performs, in virtue of its elasticity. In all these instances the same primary form of the arbitrary functions would be found; and the universality of the kind of vibration that this form indicates, affords some kind of reason (for none has yet been given) why it has been successfully employed in the undulatory theory of light.

It is necessary to know the primary form of the arbitrary function in all cases in which the vibrations are immediately impressed on the fluid by the fluid itself: for instance, when a uniform current blown across the mouth of a cylindrical pipe, puts the column of fluid in its interior in vibration. But when the vibrations are caused by the motion of a solid in the fluid, it will be true that every elementary portion of the motion may be considered a very small *portion* of a vibration of the primary kind, and will be subject to the same laws and limitations as the primary vibrations; but the total motion will receive its character from the motion of the solid, which motion determines for the particular case the form of the arbitrary function: for the equation $v = a s$ will obtain with respect to the fluid in contact with the solid. All this is a consequence of the discontinuity of the motions, which is sufficiently proved to exist by the presence of arbitrary functions in the integral.

It may be remarked that either of the equations $v = a s$, $v = - a s$, shows that where s is negative or the fluid is rarefied, the velocity of the particles is *contrary* to the direction of propagation, and where it is condensed the velocity is *in* the direction of propagation. This explains how it is that the same disturbance, for instance, the motion of a small solid forward in the fluid, produces propagations in opposite directions. For the solid must condense one part just as much as it rarefies another, but impresses motion on the particles in the direction in which itself moves; therefore the condensations and rarefactions will be propagated in opposite directions.

The

The two instances I have given of ascertaining the forms of arbitrary functions, may suffice to convey an idea of the general principles on which a like inquiry is to be conducted in any other question that is proposed. The nature of the question itself must determine the precise manner of the process.

Trin. Coll. Cambridge, Sept. 10, 1829.

XLVII. *A New Account of the Genus* Kalanchöe. *By* A. H. Haworth, *Esq. F.L.S. &c.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

HEREUNDER I send you an improved botanical account of the genus *Kalanchöe* of Adanson, to which I have added one new species from the Royal Gardens of Kew. It is a very beautiful plant, with deep yellow flowers, and was sent thither last year from the East Indies by my friend Dr. Wallich, who is now actually engaged in a very magnificent work on Indian plants, in which will be figured all the more useful and conspicuous species of that interesting country; and towards which the public at large, and more especially the botanists of Europe, look forward with the highest and most eager expectations.

The descriptions of this genus and its proper species heretofore published by myself or others, I have re-modelled, and formed the whole into new sections, to which I have added all their synonyma (as far as practicable to me), so as to give a monographical sketch of the genus. Hoping the result will prove acceptable to your botanical readers,

I remain, Gentlemen, your old Correspondent,

Chelsea, Aug. 5, 1829. A. H. Haworth.

Ordo Naturalis. Crassulaceæ, *De Cand.* Prod. Syst. Veg. 3. 395.

Genus *Kalanchöe*, *Adanson*, Fam. 2. page 248.—*De Cand.* l. c.—Persoon Synops 1. 446.—*Nob.* Synops. Succ. 109. *Vereia*, *Kennedy* in Bot. Rep. t. 21.—*Willd.* Sp. Pl. 2. 471. *Cotyledonis* pars *Linn.*—*Sims* in Bot. Mag. 1436. *Brown* in *Hort. Kew*, ed. 2. v. 3. 110.

Generis Character.

Calyx 4 (rarissimè 5) sepalis, basi ipsâ solùm concretis, lorato-acutis, supernè subpatenti-recurvulis. *Corolla* hypocrateriformis,

formis, 4-(rarissimè 5-)fida, laciniis tubo obversè clavato, plùs duplò brevioribus. *Stamina* 8, horum 4 ferè ad medium tubi, et 4 alia ferè ad apicem ejus internè adnata; aliquantillum (prope *antheras* ovato-oblongas) solùm libera. —*Squamulæ* ordinariæ obsoletè in *K. varians*. Cætera non examinavi. *Carpella* (cum *stylis* continuantibus) subulata internè planiora (et demùm internè dehiscentia); *stigmate* inconspicuo, per lentem capitulari pallido: *seminibus* numerosis parvis; sed incipientia oblonga solùm vidi. *Obs.*—*Suffrutices* 1—2 pedales erecti, parùm ramosi succulenti, sæpissimè glabri; Africani, Sinenses, vel ex India Orientali. *Folia* decussatim distantia carnosa opposita (*K. alternans* fortè excepta) decurrenter grossè petiolata, plùs minùs irregulariter pinnatisecta, vel ovata, dentata serratave; et sæpissimè glaucescentia. *Flores* cymosè paniculati terminales erecti jasminei, sæpiùs flavi, subrufescentes, vel rarissimè albi, inodori, semper aperti. Genus naturalissimum, speciebus inter se distinctis.

SPECIERUM Characteres.

* *Foliis pinnatisectis.*

ceratophylla. K. (Double-pinnate) foliis pedato-bipinnatifidis, inciso-grandè dentatis, pallidè viridibus, caule ramoso.
1.

Nob. in Revis. Pl. Succ. p. 23.—*De Cand.* Prod. Syst. Veg. 3. 295.—Planta Anatis, *Rumph.* 5. 96.

Habitat in Sina.

Floret in Hort. Kew, Nov.—Jan. sed flavos flores non vidi. St. ♄.

Obs. Minùs erectus quàm in sequentibus.

laciniata. K. (Pinnate-leaved) foliis simpliciter pinnatifidis glaucis, pinnis grandè inciso-dentatis.
2.

Kalanchöe laciniata. *Nob.* in Synops. Succ. 111.—*De Cand.* Pl. Gr. icon. 100; et Prod. Syst. Veg. 3. 395, excluso synon. *Rumph.*, quod ad præcedentem pertinet.—Cotyledon laciniata. *Linn.* Sp. Pl. 1. 615; et Hort. Cliff. 175, synonymis confusis.—Cotyl. *Willd.* Sp. Pl. 2. 758.—Cot. afra laciniata, &c. *Boerh.* Ind. Alt. 1. 288. cum icone.

Habitat in India. Ægypto?

Floret in hortis rarissimè Jul. Aug. St. ♄.

Obs. Minùs ramosa quàm in præcedente; stricta, floribus luteis terminalibus paniculatis.

Obs.

Obs. Calenchöe laciniata *Pers.* Synop. 1446 est Bryophyllum calycinum auctorum aliorum.

*** Foliis simplicibus, vel in sequenti, rarissimè tricuspidatis.*

varians. K. (Trifid Indian yellow) lævis; glauca: foliis
3. ovalibus grandi-dentatis, supremis quandoque tricuspidatis.

Habitat in Indiâ Orientali. St. ♄.

Floret Jul. Aug. St. ♄.

Obs. Suffrutex, subsimplex erectus bipedalis carnosus, folio supremo uno alterove plùs minùs trifido, laciniis lineari-lanceolatis subedentulis, infra *bracteas* distantes omninò foliiformes integras sensim sensimque minores. *K. alba,* infrà simillima, floribus majoribus valdè paniculatis. *Corolla* 4-(rarissimè 5-)fida, laciniis ovato-acutis flavissimis; extus, cum tubo angulato obclavato sesquiduplò longiore, pallidiores. *Stamina* ut in generico charactere, *stylis* altitudine staminum 4 inferiorum.

Folia suprà sæpè obsoletè venulosa, *subtùs* polita avenia lævia nitida; petiolis valdè grossis, et ut in affinibus supernè canaliculatis. Dignoscitur optimè folio suprà dicto tricuspidato, hujus laciniis lateralibus integris, terminali apicem versus paucidentato.

crenata. K. (Large oval-leaved yellow) foliis oblongo-lan-
4. ceolatis, grandi-crenatis; crenis subindè duplicatis. Kalenchöe crenata. *Nob.* Synops. Succ. 109.—Kalenchöe Vered, *Persoon* Synops. 1. 446.—Kal. crenata *De Cand.* Prod. Syst. Veg. 3. 395.

Vereia crenata, *Kennedy* in Bot. Rep. 1. 21.—*Willd.* Sp. Pl. 2. 471.

Cotyledon crenata.—*Sims* in Bot. Mag. 1436.

Telephium africanum. *Pluk.* Alm. 228. f. 3.

Habitat in Africâ, prope Sierram Leonem.

Floret Aug. Sept. St. ♄.

Obs. Flores effuso-paniculati flavi; vel sæpiùs paniculâ minore, cum foliis minùs vel vix duplicato-crenatis.

acutiflora. K. (White-flowered Indian) foliis lato-lanceo-
5. latis crenatis glabris, crassis: corollæ attenuatæ albentis, laciniis oris acutiusculis.

Kalanchöe acutiflora. *Nob.* Synops. Succ. 109.—*De Cand.* Prod. Syst. Veg. 3. 395.

Vereia acutiflora. *Kennedy* in Bot. Rep. 560.

Habitat in Indiâ Orientali.

Floret

Floret Aug. Sept. St. ♄.

Obs. Flores cymosè paniculati, et quàm in prioribus graciliores minores acutioresque.

lanceolata. K. (The villous Arabian) foliis lanceolatis apice
6. crenatis, caule pedunculis calycibus corollisque villosis, cymâ paniculatâ.

Kalanchöe lanceolata. *De Cand.* Prod. Syst. Veg. 3. 396.

Cotyledon lanceolata. *Försk.* Descr. 89.

Habitat in Arabiâ. ♄.

Obs. Non vidi. Flores dicuntur flavo-rubentes.

alternans. K. (Alternating Arabian) foliis orbiculato-spathu-
7. latis integerrimis, paniculis glabris. *De Cand.* Prod. Syst. Veg. 395.—Cotyledon orbiculata, *Försk.* Cat. secundum DeCandolle, l. c.

Habitat in Arabiæ montium regione mediâ. Non vidi. Non est Cotyledon alternans, *Nob.* in Supp. Pl Succ. p. 28; quæ mutavi in *Cotyledonem maculatam,* in Revis. Pl. Succ. 21.

rotundifolia (pale rufescent Cape) stricta, gracilis: foliis cras-
8. sis; imis rotundatis, superioribus obovatis subintegris; floribus parvis pallidè rufescentibus aureisve.

Kalenchöe rotundifolia. *Nob.* in Philos. Mag. Jul. 1825. p. 31.—*De Cand.* Prod. Syst. Veg. 3. 396.

Crassula rotundifolia. *Nob.* in Philos. Mag. Sept. 1824, cum descriptione caulis foliorumque solùm.

Habitat ad Caput Bonæ Spei, ubi legit amicus Dom. Bowie.

Floret hyeme, at adhuc imperfectè, apud nos. St. ♄.

Obs. A. K. *Ægyptiacâ* discrepat, foliis minùs dentatis rotundioribus, calyce magis adpresso.

ægyptiaca. K. (Orange Ægyptian spathulate) foliis obo-
9. vato-spathulatis crenatis, infimis obtusis subconcavis, superioribus acutis, cymâ paniculato-subconfertâ. *De-Cand.* Prod. Syst. Veg. 3. 395. et in Pl. Gr. t. 64.

Obs. Flores non vidi: sed secundum *De Cand.* l. c. aurantiaci, pedicellis pubescentibus in plantâ herbaceâ et eâdem authoritate, est Cotyledon nudicaulis, *Vahl.* Symb. 2. 59, et Cotyledon integra, *Medik.* Comm. Pal. 3. p. 200, t. 9; et Cotyledon deficiens Försk. Descr. 89.

Habitat in Ægypto ad Montem Melhan. ♃. *De Cand.* l. c.

Floret Aug. Sept. St. ♃.

spathulata. K. (Chinese yellow spathulate) foliis obovato-
10. spathulatis crenatis glabris, infimis obtusis, superioribus

bus acutis, cymâ paniculatâ laxâ. *De Cand.* in Pl. Grass. t. 65, et Prod. Syst. Veg. 3. 395.—*Nob.* Revis. Pl. Succ. 23.

Cotyledon hybrida. *Hort. Par.*—Cotyl. spathulata. *Poiret* Suppl. 2. p. 373, secundum *De Cand.*

Habitat in Sinâ.

Floret Aug. Sept. St. ♃.

Obs. Flores non vidi, sed secundum *De Cand.* l. c. flavi, "quâ notâ facilè distinguitur à precedente, cui valdè affinis."—*Folia* apud nos duplò latiora quàm in priore, sed minùs crassa, et obsoletè solum crenata.

XLVIII. *Notices respecting New Books.*

The Influence of Climate in the Prevention and Cure of Chronic Diseases, more particularly of the Chest and Digestive Organs; comprising an account of the principal places resorted to by Invalids in England and the South of Europe; a comparative estimate of their respective merits in particular diseases, and General Directions for Invalids whilst travelling and residing abroad: with an Appendix containing a Series of Tables on Climate. By JAMES CLARK, M.D. *Member of the Royal College of Physicians of London, &c.*

IT has been remarked by the late Dr. Young, that "in proportion as both the medical and meteorological sciences become founded on a firmer basis, it cannot be doubted that their beneficial effects will be more and more experienced, as well in the preservation of health as in the treatment and cure of diseases."

The work before us must be regarded as one of the most important efforts which have as yet been made toward the verification of this assertion of the philosopher, whose death has so recently deprived our country of one of its brightest ornaments.

The influence of climate in the prevention and cure of diseases is, to borrow the words of Dr. Clark, "for many reasons a subject of peculiar interest to the inhabitants of this country. To the inclemency of our seasons we are justified in attributing some of our most fatal diseases; and many others of great frequency, if they do not derive their origin immediately from our climate, are at least greatly aggravated by it.

"Among this number may be ranked pulmonary consumption, and some other fatal diseases of the chest: scrophulous affections; rheumatism; disorders of the digestive organs; hypochondriasis, and a numerous train of nervous disorders, &c. For the prevention of some, and the cure of others of these diseases, a temporary residence in a milder climate is the best and often the only effectual remedy which we possess."

Our countrymen are generally sufficiently willing to make trial of a therapeutical agent, so peculiarly congenial to our national taste. The necessity of correct and sufficient directions, with respect both

 to

to the course to be pursued, and the season at which the journey is to be taken, has therefore been very frequently experienced by the patient or his family; and the physician consulted on the occasion must almost as often have felt that the difficulty was transferred rather than removed by the reference to him.—The reason is obvious. Few even of our most travelled physicians have themselves visited a sufficient number of the places usually resorted to by invalids, or remained at them for a sufficient length of time, to enable them to form correct opinions of their comparative merits.

Those who have not travelled, must of course derive their information on the subject from occasional opportunities of conversing with those who have, and from the incidental, necessarily incomplete, and often prejudiced remarks scattered through the pages of almost innumerable tourists.

The medical character of particular places, with reference to the single point of temperature alone, is under the influence of so many causes, that it is notorious that very imperfect notions can be formed from the mere consideration of latitude. Many travellers have been careful to note the height of the thermometer and barometer at different places during the period of their stay; but such records, though by no means to be despised, cannot give an idea of the thermometric range which forms a most important feature in the medical characters of climate. A pretty good, but somewhat empirical mode of judging of the character of a spot, with respect to climate, consists in the examination of its Flora; but there is so much difference between the constitutions of vegetables and animals, that, however desirable such observations may be as collateral evidence, it cannot be safe, in the selection of the residence of an invalid, to trust to conclusions drawn from them alone.

In the work before us, Dr. Clark has endeavoured first to point out the physical characters of the climate at the different places of which he treats, as drawn from meteorological registers. Of these the Doctor's own researches, aided by the contributions of his friends, have enabled him to collect no inconsiderable number. Still it must be confessed that much remains to be done with respect to this point. There are many places in which no registers have been kept; and in some, imperfection in the instruments has conspired with other causes to render further observation desirable.

In the second place the author examines what has been the result of experience as to the effects produced by the climate: and finally, from the combined results of the two preceding sources of infromation, he endeavours to deduce the characteristic medicinal qualities of each particular climate.

Of a large proportion of the places noticed in the work, Dr. Clark speaks from his own personal observation; but where this advantage has been wholly wanting, or but imperfectly possessed, he has invariably derived his information from authentic and valuable sources.

The

The treatise is divided into two parts. In the *first part* the author describes the peculiarities of climate in most of the situations which are likely to be resorted to by British invalids for the benefit of their health. He commences by a few remarks respecting the climate of London and its vicinity, and the accidental causes by which it is modified. The south coast of the island is next spoken of; and the respective merits of Hastings, Brighton, Gosport, Southampton, and the Isle of Wight, are particularly examined. From the south the author proceeds to the south-west; and Torquay, Dawlish, Exmouth, and Sidmouth in Devonshire, and Penzance and Flushing in Cornwall, obtain particular attention.

Penzance not only possesses a mean annual temperature at least equal to that of any other place in this country; but, as the author proves by reference to meteorological registers, has the important advantage of presenting a much greater equability of temperature, both with respect to the diurnal and the annual range of the thermometer, not only than any other spot in this country, but also than the south of Europe, or any other situation with which it has been compared, Madeira alone excepted.

In the duration of the same temperature, as shown by the mean variation of successive days, the climate of Penzance excels all the northern climates, and nearly equals Rome and Nice in this respect; but as compared with Madeira, its temperature from day to day varies twice as much. In the spring it loses its superiority of climate; and in April and May it appears decidedly inferior to the coast of Devonshire, and very much so to the south-west of France.

The merits which the district of Penzance possesses, with respect to temperature, are not accompanied by proportionate advantages in the other elements of climate There falls at Penzance nearly twice as much rain as in London: the annual average at the former place being 44, and at the latter only 25 inches; it is also liable to violent and frequent storms of wind.

Bath, Bristol, Clifton, and Cheltenham, are afterwards noticed, as belonging to the western district of this island.

In treating of the parts of France which are resorted to by invalids, Dr. Clark divides them into two districts, that of the west and south-west; and that of the south-east. In the former he particularizes Paris, and in the latter, Montpélier, Marseilles, Aix, and Hyères.

To Nice the Doctor has devoted a distinct chapter, and then proceeds to speak of the climate of Italy. From his long residence in that country, with the best of opportunities for seeing and learning the influence of different spots upon invalids of various descriptions, he has been able to state much from his own observation and experience. This chapter is therefore particularly interesting.

Those who have recourse to a journey to Italy for the benefit of a milder winter, are necessarily exposed to the inconvenience of a proportionally hotter and longer summer, unless they take the precaution of recrossing the Alps to avoid it, or return to

those

those spots in which local peculiarities conspire to counteract its influence. To the merits of these two plans, and to the mode of carrying them into execution, the Doctor has devoted one chapter, in which he also takes occasion to notice the climate of Switzerland, and the advantages which it offers to invalids.

The last chapter of the first part of the work is devoted to Madeira: although we cannot subscribe to the remark of Dr. Adams, when he says with reference to patients sent to this island, "that in cases of tubercular or scrofulous consumption, if the patient does not saunter away his time, after you have advised him to leave England, we can with certainty promise a cure;" yet in most respects, the medical climate of Madeira appears to be superior to that of any other place with which it has been compared. For equability of temperature it is pre-eminent; and although, as its latitude would have led one to presume *à priori*, the annual fall of rain is considerable, this is very much confined to particular seasons, and admits of a very large proportion of fine days. A great and almost peculiar advantage to be found in Madeira is, that it is perhaps equally calculated for a summer as for a winter residence. The mild character of the climate appears to be accompanied with a corresponding degree of health to the inhabitants of Madeira. The peasantry, though as hard worked and badly fed as in any part of the world, are said to be as fine, healthy, and robust a race as are to be seen in any country. This island is almost exempt from the diseases peculiar to warm climates, and little subject to many of those which are common in more northerly countries: yet it must be confessed, that of the patients who take refuge in this most favoured spot, a large majority fail to derive from it the benefits which they anticipate. In incipient cases the greatest advantages have been obtained from a visit to Madeira; but with respect to those which are confirmed, we cannot refrain from repeating the remarks of a very intelligent resident physician, Dr. Renton, as quoted by Dr. Clark.

"When consumption has proceeded to any considerable extent, I should consider it the duty of a medical attendant, not only not to advise the adoption of such a measure, but most earnestly to dissuade from it those who from hearsay evidence of the recovery of others in circumstances similar to their own, may feel disposed to fly to it as a last resource."

Patients who might really have derived much benefit from climate, have been too often sent abroad without proper directions respecting the situation most suited to their complaints, and altogether uninstructed respecting various circumstances, a due attention to which could alone render the best selected climate beneficial to them.

The *second part* of the work before us is designed to lessen and remedy this evil, by presenting some valuable dietetic instructions, and by an inquiry respecting the nature of the maladies which are likely to be benefited by climate; and by pointing out the varieties of those diseases to which the peculiarities of different situations,

situations, with reference to their climates, appear particularly adapted.

Were we to attempt an analysis of this part, in which the author treats of *disorders of the digestive organs, of consumption, of disorders of the larynx, trachea and bronchea, gout, chronic rheumatism, general delicacy of constitution in childhood and youth, premature decay at a more advanced period of life, and of disordered health from hot climates*,—we should far exceed our prescribed limits, and at the same time be encroaching on the province of the more exclusively medical reviewer.

We must not however take leave of the volume without strongly recommending it to our readers; and remarking, that, whilst it contains much valuable information for the professional man, the style and matter are such as to fit it for the general reader, and render it extremely attractive to those who, either on their own account or on that of their friends, feel a special interest in the curative or prophylactic influences of climate.

XLIX. *Proceedings of Learned Societies.*

ROYAL ACADEMY OF SCIENCES OF PARIS.

March 2.—*MANUSCRIPTS presented to the Academy:* Tables for teaching arithmetic, by M. Fabret.—New observations respecting a method which will admit of weavers working in all kinds of apartments, by M. Dubui.—Upon a portable reflective compass for observing the diurnal variations of the horizontal needle, by M. Babinet; and a sealed packet by the same.

M. Dumeril, in the name of a commission, gave a favourable account of the memoir by MM. Villermé and Edwards, on the influence of temperature on the mortality of new-born infants.

M. Mirbel, in the name of a commission, gave a disadvantageous report on M. Aiguebelle's new processes for drawing, which he terms *homography*.

MM. Cuvier, Fourier, Poinsot, Gay-Lussac, Thénard, and Desfontaines, were constituted a commission to name candidates for the appointment of foreign associate, vacant by the death of Dr. Wollaston. —M. Cagnard-Latour read a memoir on the action of acids upon carbon.—M. Jobert read a dissertation upon a lower jaw of the Antracotherium, discovered on the right bank of the Allier, in the department of Puy-de-Dôme.—M. Poisson presented a notice relating to the imaginary roots of transcendental equations.

March 9.—*Manuscripts presented:* A letter from Dr. Cottereau on the advantageous employment of chlorine gas in phthisis.—Considerations on the true croup, and means of cure when at the worst period, by M. Bertonneau.—On a new mode of breaking the stone, by M. Heurteloup.—A sealed packet of new surgical instruments, by M. Tanchou.—A letter from M. Le Gigant, to obtain the decision of the Academy respecting some precious stones which are in his possession.—A letter from M. Babinet on his method of determining the intensity of terrestrial magnetism at Paris.—M. Fourier presented a fresh

a fresh notice relating to the imaginary roots of transcendental equations.—M. Hericart de Thury gave a notice respecting overflowing wells.—M. Cuvier, in the name of a commission, gave an advantageous account of the labours of M. Reynaud, surgeon of the Chevrette, during a voyage to India.—M. Pouillet read a memoir respecting the measurement of high temperatures in degrees of the air thermometer. —M. Rozet read a geognostic notice respecting some parts of the departments of Ardennes and of Belgium.

March 16.—*Manuscripts:* A letter from M. Baudelocque respecting the extraction of infants with improved forceps.—Ideas on the formation of the diamond by M. J. Baruffi of Turin.—Description of an apparatus employed by M. Cottereau for the administration of chlorine.—A new method of proving gunpowder, by M. Barré.—MM. Chevalier and Langlumé on trials by means of a siliceous stone. —A new method of curing stammering, by M. Sene d'Usez.—Mechanism for travelling in the air, by M. Masucci of Rome.—Various letters from MM. Quoy and Gaymard, on the voyage of the Astrolabe. —Letters from MM. Tournal et Marcel de Serres, on the bones discovered in the caverns of Bise.—On the application of Taylor's theorem to the solution of numerical equations, by M. Cauchy.—On the relative organic structure of antediluvian animals, those mentioned in history and of the present time.—M. Silvestre, in the name of a commission, gave a favourable account of the experiments made by M. Bonafous of Turin, upon the comparative advantages of the leaves of the wild and grafted mulberry trees.—M. Cuvier, in the name of a commission, made an advantageous report respecting the collections and designs in natural history, recently brought from Egypt by M. Rifaut.

March 23.—*Manuscripts:* A letter from M. Berlau on the necessity of re-vaccination.—A notice respecting the lightning conductors put up in la Place de Valencienne by M. Barré, of the Artillery. —On certain oscillatory motions, produced by the ores of the island of Elba.—Extract of a letter from M. Humboldt to M. Arago, on the phænomena of the magnetic needle.—Description of a new genus of the family Geraniaceæ, by M. Cambassides.—A letter from Dr. Lassis, announcing new facts confirmatory of his ideas respecting the epidemic of Gibraltar.—Some details by Mr. Warden, on part of the N.W. coast of the United States, near the river Colombia.

The Academy proceeded to the election of a foreign associate. M. Olbers had 39 votes, Mr. Dalton 14, and M. Plana 1.—M. Cauchy reported that M. Duchatel's memoir on the division of an arc into any number of equal parts, was unworthy of any notice.—M. Geoffroy Saint-Hilaire read the first part of his memoir on the relations between the structure of antediluvian and present animals.

March 30.—*Manuscript communications:* A letter from Dr. Lallemand of Montpelier, stating that he cured a large rupture of the bladder by a suture.—Monograph of the amphipodes crustaceæ, by M. Milne Edwards.—Memoir on the geological division of territories, by M. Jobert, Sen.—A report was read respecting the powder magazine of Bayonne, which was struck by lightning.—A report by M. Poinsot,

respecting

respecting a memoir by MM. Dubois-Aymé and Bigeon, on the development, of plane curves; it contained nothing new, but some varied examples, which may be useful —A report by M. Cauchy on a work by M. Paulet, relative to the theory of numbers, which contained nothing worthy of attention.

MM. Despretz and Cagniard-Latour terminated the sitting by reading two memoirs; the former on the modifications which metals undergo in their physical properties by the combined action of heat and ammoniacal gas; the latter on the cause of the sounds which are produced by blowing with the mouth.

April 6.—*Letters and Manuscript memoirs:* A letter from M. Quoy on the geological collections made during the voyage of the Astrolabe.—Lithographic proofs retouched after the first impressions, by a process invented by MM. Chevallier and Langlumé.—A memoir by M. Robert, physician to the Lazaretto of Marseilles, on the identity of the epidemic of Paris and of a disease known in the Antilles by the name of *giraffe* or *colorado.*—A letter from M. Serullas on the iodide of azote.—A note relative to Roberval's method of tangents, by M. Duhamel.—A letter from M. Julia-Fontenelle, containing an analysis of an Italian work by Dr. Trevisan, on the mortality of new-born infants. —A memoir on the condensations and linear dilatations of solid bodies, by M. Cauchy.

April 13. *Letters and Manuscript memoirs:* A memoir by M. N. Le Bœuf, on the annual motion of the earth. - New observations on the yellow fever, by M. Leymerie.—A notice respecting the longevity at the commencement of the 19th century, by M. Benoiston of Chateauneuf.—A letter from M. Serullas, announcing that the chloride of azote of chemists is a chloride of azotized hydrogen.—Description of a new lighting apparatus by MM. Galy, Caralat, and Dubain.—M. Blainville gave an account of the description of the whale cast on shore, in the department of the eastern Pyrenees, which MM. Farines and Carcassonne had sent to the Academy.—M. Cuvier reported on the memoir of M. Roulin respecting a new species of Tapir, which he had found in America.—M. Tessier gave a verbal account of a work published by M. Le Vicomte d'Harcourt, intitled " Reflections on the agricultural and commercial state of the central provinces of France." —M. Poisson gave a favourable account of M. de Pontécoulant's memoir relating to the part of the inequalities of Jupiter and Saturn, which depends upon the square of the perturbating force.—M. Poisson read a notice on the intimate constitution of fluids.

L. *Intelligence and Miscellaneous Articles.*

DERIVATION OF THE WORD *THEODOLITE.*

A CONSTANT READER wishes to know the derivation of the word *Theodolite;* the derivation given in Johnson's Dictionary, from θεαω *I see,* and δολιχος *long,* not being quite satisfactory either as to the formation of the word, or as the name of an instrument for measuring horizontal angles.—And likewise whether the in strument is of British or of French origin.

PREPA-

PREPARATION OF UREA, BY M. HENRY, JUN.

Add a slight excess of subacetate or hydrate of lead to fresh urine; the precipitate contains the salts formed by the union of the metallic oxide with the acids of the salts of the urine, and a compound produced by the combination of the mucus and a great part of the animal matter, with the hydrate or subsalt employed *.

The decanted fluid is treated with diluted sulphuric acid slightly in excess, to separate all the lead, and to act afterwards during evaporation upon the acetates of soda and lime which may be formed. After having separated the white precipitate, the liquid is quickly evaporated, and animal charcoal added during ebullition. When the fluid is clear, it is to be strained through a fine cloth, and evaporated to about one third of its bulk; on cooling, the liquor frequently becomes a yellowish acicular crystalline mass, consisting of much urea and some salts. The crystals when drained and pressed are to be added to those produced by evaporating the mother water, also similarly treated; being thus deprived of the brown viscous matter which enveloped them, the crystals are to be treated with a small quantity of carbonate of soda, to decompose any acetate of lime which may remain, and they are then to be digested in alcohol; the solution filtered and distilled leaves urea, which may be re-crystallized by solution in water and evaporation.—*Journal de Pharmacie*, April, 1829.

A NEW PYROMETER, BY M. POUILLET.

This instrument is an oval vessel of platina, soldered to a tube of the same metal of known capacity: this vessel communicates with a graduated tube, so that the increase of volume occasioned by the rise of temperature may be immediately read. To use this pyrometer, the platina vessel is to be placed in the furnace, the temperature of which is to be known; the original volume of the air or gas contained in the instrument being known, the temperature is determined by the increase of its volume.—*Ibid.*

POISONING BY CHEESE.

Dr. H. L. Westrumb of Hameln, found that seven persons were poisoned by decayed or damaged cheese (*fromage passé, fromage gâté*). M. Sertürner analysed this cheese and found in it a peculiar acid, which appeared both to him and to M. Westrumb to be the poisonous principle; the analysis was performed with ether and alcohol. Three different substances were obtained from the cheese: viz.

1st. Caseate of ammonia.

2dly. An acid fatty, or resinous cheesy, matter.

3dly. An acid but less fatty matter.

These substances, tried separately upon dogs and cats, showed that the first was the least poisonous, the third more so, and the second the most poisonous of all. The symptoms occasioned by the poison

* This deposit, well washed and treated while hot with solution of carbonote of potash, yields a liquid, from which a large quantity of uric acid may be precipitated by excess of muriatic acid.

in

in these animals were similar to those occasioned in man; they were at first nervous, and then followed by intestinal inflammation. One phænomenon especially remarkable, was the production of an enormous quantity of ammoniacal gas in the intestines; this resulted from an organic secretion, for the fatty poisoning matters did not contain any ammonia whatever —*Ibid.* June 1829.

BROMIDE OF CARBON, BY M. SERULLAS.

To form this compound, two parts of bromine are to be added to one part of periodide of carbon, and just enough solution of potash is to be added to cause the iodine, set free, to disappear; the liquid bromide of carbon which will appear at the bottom of the solution, is to be separated by a funnel or otherwise, but without washing with water, and allowed to stand until it has become quite clear; during this time a quantity of iodate of potash, in crystals, will rise to the surface; the clear fluid beneath is to be withdrawn, and put into a weak solution of potash, for the purpose of decomposing a little protiodide of carbon formed at the same time; a little bromide is also decomposed, but that which remains is soon left in a pure state.

This bromide very much resembles the protiodide of carbon; they are both heavier than water, have at first the same appearance under its surface, the same ethereal and penetrating odour and sweet taste; both are liquid, and when washed with solution of potash to remove the impurities, both are colourless.

The differences between the bromide and the iodide of carbon are as follows: the first becomes solid, hard, and crystalline, at 32° Fahr., and remains solid up to 43°; the latter remains fluid at the lowest temperatures. The first when heated in a spirit flame, gives red vapours, the latter violet vapours; neither burns with flame; but the fluid hydrocarburet of bromine does burn with flame. Neither of the two appears to act upon water, but a little alkali added, causes their decomposition slowly.

The analogy which exists between the compounds of chlorine, bromine, and iodine, is very remarkable when these bodies are combined with carburetted hydrogen or with carbon.

1st. Three ethers, considered by M. Chevreul as hydrochlorate, hydrobromate, and hydriodate of carburetted hydrogen.

2nd. *Chlorine and Carbon.* Two chlorides of carbon, one solid and the other liquid, possessing a camphorated aromatic odour.

3rd. *Bromine and Carbon.* One bromide of carbon, which is fluid, of an ethereal penetrating odour, solidifying at 32° Fahr., tastes very sweet.

4th. *Iodide and Carbon.* Two iodides of carbon; one solid, crystalline, with a strong aromatic saffron-like odour; the other fluid, with a penetrating ethereal odour: both sweet to the taste.

5th. *Chlorine and Carburetted Hydrogen.* Hydrocarburet of chlorine, but ought to be termed chloride of carburetted hydrogen: this compound is liquid, has an ethereal odour and a sweet taste.

6th. *Bromine and Carburetted Hydrogen.* Hydrocarburet of bromine (*bromide of carburetted hydrogen*). This substance is liquid, has a very

a very sweet smell; solidifies at about 20° Fahr.; its taste very sweet.

7th. *Iodine and Carburetted Hydrogen.* Hydriodide of carbon of Faraday (*iodide of carburetted hydrogen*). This is solid, crystalline, of an aromatic odour and sweet taste.

The composition of the iodides of carbon is given as follows:—

Protiodide.			*Periodide.*		
Iodine	1 atom	·99528	Iodine	3 atoms	2·98584
Carbon	1 ——	·00462	Carbon	2 ——	·00924

Annales de Chim. et de Phys. xxxix. 225.

PREPARATION OF PIPERINE.

The following is M. Vogel's process and result:—Sixteen ounces of coarsely powdered black pepper was digested in double its weight of water for two days, five times in succession, and the residue strongly pressed and dried. It was then digested for three days in 24 ounces of hot alcohol; the fluid pressed out, filtered, distilled and ultimately evaporated to a syrup. The impure crystals of piperine deposited on cooling, were washed with ether, to remove resin, then dissolved in three times their weight of hot alcohol, sixty grains of animal charcoal added, the liquid filtered and evaporated spontaneously, when 110 grains of pale yellow crystals of piperine were obtained. On repeating this process with the residue of the maceration, seventy grains more were obtained.

According to other experiments, it appears that the green acrid resin in the pepper, which in the above process was dissolved by the ether, is the active and febrifuge principle in pepper, rather than the insipid piperine.—*Brande's Archives*, vol. iv. p. 221.—*Quarterly Journal*, June 1829.

ANALYSIS OF ARSENIATE OF IRON.

M. Boussingault has analysed the arseniate of iron, which occurs in a vein of auriferous hydrate of iron, in decomposed porphyritic grunstein at Loaysa near Marmato, in the province of Popayan. The results are as follows:—

		Or freed from the gangue.	
Arsenic acid	45·8	Arsenic acid	49 6
Peroxide of iron	31·7	Oxide of iron	34·3
Oxide of lead	00·4	—— lead	00·4
Water	15·6	Water	16·9
Alumina	02·6		
Silica	05·0		
Oxide of copper	(traces)		101·2
	101·1		

The increase of weight probably arises from the peroxidation of a part of the iron.—*Annales de Chim. et de Phys.* xli. p. 75.

SUGAR FROM STARCH.

M. Weinrich says, that from one to two parts of sulphuric acid for

for each 100 parts of potatoe starch is sufficient, if the heat applied be a few degrees above 212° Fahr.; and also that then two or three hours are sufficient to give crystallizeable sugar. He applies heat in wooden vessels by means of steam.—*Quarterly Journal*, June 1829.

AMMONITES IN CALCEDONY, FROM HAYTOR?

We have received from Mr. Shirley Woolmer, of Exeter, two communications respecting the occurrence of ammonites in calcedony from Haytor. In one specimen, bearing also crystals of quartz and haytorite (some of the latter of a crimson hue), and "red blistered manganese" is stated to be "a yellow ammonite of one-fourth of an inch in diameter, with three circumvolutions;" also "six ammonites of two circumvolutions, three of which are very discernible with a glass; the others are rather obliterated." Besides these, in a small round cell is "a black ammonite, with two circumvolutions." Mr. Woolmer observes, that "the external character is that of the *Cornu Ammonis*, with evident whirls and ridges; similar ones were discovered by Harenberg in Germany, hardly perceptible except with a glass; they are very abundant in many specimens I have of Haytor calcedony. I extracted several of them, but they were so brittle that they crumbled to pieces on my attempting to try an experiment upon them: the nearest approach to them is in the 3rd volume of Parkinson's Organic Remains, plate xi. fig. 26, 27, 28. These figures are more distinct, but of the same character."

ACTION OF MURIATIC AND SULPHURIC ACID UPON HYDROCYANIC ACID.

M. Kuhlman states that he has sometimes preserved hydrocyanic acid, prepared according to M. Gay-Lussac's process, for some years without alteration, whilst at other times it has decomposed within a week of its preparation. To determine the causes which accelerate or retard this decomposition, the action of muriatic acid was tried upon the hydrocyanic.

When these acids were mixed, the bottle which contained the mixture was sprinkled with fine cubic golden yellow-coloured crystals in twelve hours; some of the crystals were hopper-shaped, like common salt. Several of the crystals were less deeply coloured, and those which were precipitated by longer contact were quite colourless. The liquor retained its limpidness, and was diminished nearly to one half by the formation of the crystals.

The experiment was repeated by mixing equal quantities of the two acids, the hydrocyanic acid being recently prepared. No yellow crystals were obtained, probably on account of the excess of muriatic acid; but a great quantity of colourless crystals was obtained, which resembled those procured towards the end of the former operation.

These white crystals were heated in a glass tube, and converted into a white vapour, which condensed in a powdery form; potash and lime separated ammonia from them, they were very soluble in water,

and

and nitrate of silver gave an abundant precipitate in the solution; they appeared to be entirely muriate of ammonia. The yellow crystals obtained in the first experiment became colourless when heated, and the colour was probably owing to an excess of hydrocyanic acid: no gas was evolved when the acids were mixed.

Sulphuric acid added to the hydrocyanic gave no crystals until the mixture was heated; by this operation an inflammable gas, probably carburetted hydrogen, was plentifully evolved; the mixture remained colourless, and on cooling solidified into a colourless crystalline mass, which was sulphate of ammonia.—*Annales de Chimie*, xl. p. 441.

NEW PRINCIPLE OBTAINED FROM ALBUMEN.

M. Couerbe exposed a concentrated solution of white of egg to the air, the temperature varying from 32° Fahr. to several degrees below it. The albuminous mass, without coagulating, became rather thicker, and at the expiration of a month it gave a membranous network in considerable abundance, and a fluid, upon which but few experiments were made. During this time no putrid gas was evolved; the fluid yielded carbonate of ammonia by decomposition; this circumstance proves that it is to be considered as the animal part of the albumen. The network membrane, which was most particularly examined, possessed the following properties:—it is solid, white, translucid, and of a membrano-foliaceous structure; it is insipid and inodorous, and easily reduced to powder.

Exposed to the action of heat, in a tube closed at one end, it decomposed without fusing, and gave all the products of a non-azotized body: during calcination, it swells up and gives a light voluminous charcoal, which it is difficult to incinerate. When treated with oxide of copper in a proper apparatus, it yielded merely carbonic acid and water.

Cold water does not dissolve the smallest portion of this membrane; it merely remains between the foliaceous laminæ and softens it; boiling water swells, without dissolving it, divides it a little and gives it the appearance of an insoluble mucilage; it is not acted upon by alcohol, sulphuric æther, or acetic acid, either hot or cold. At common temperatures it merely swells in concentrated sulphuric acid; but it is carbonized on the slightest application of heat, and gives an agreeable aromatic odour; the mixture is insoluble in water; the acid only combines with it, and the carbon is precipitated or remains partly suspended. In the cold, nitric acid acts but feebly upon it, but when heated the membrane is dissolved, with the evolution of nitrous gas. Hot muriatic acid is the best solvent of the new substance; the solution is colourless, and does not become turbid by cooling; when water is added to the solution, it becomes of an opake white, and deposits a powder of extreme tenacity.

Subjected to the action of potash and heat, the membranous substance dissolves; the solution is decomposed by muriatic acid and becomes turbid, but does not give any deposit in twenty-four hours. *Ibid.* p. 323.

LIST OF NEW PATENTS.

To E. Galloway, King-street, Borough, Southwark, for improvements in steam-engines and machinery for propelling vessels.—Dated the 2nd of July, 1829.—6 months allowed to enrol specification.

To J. Perkins, Fleet-street, engineer, for improvements in machinery for propelling steam-vessels.—2nd of July.—6 months.

To T. Kelby, Wakefield, York, clerk, and H. F. Bacon, Leeds, gent., for their new or improved gas-lamp burner.—2nd of July.—6 months.

To R. Crabtree, Halesworth, Suffolk, gentleman, for his machine or apparatus for propelling carriages, vessels, and locomotive bodies.—4th of July.—6 months.

To M. Knowles, Lavender-hill, Battersea, Surrey, spinster, for her improvement in axletrees, and mode of applying the same to carriages. 4th of July.—6 months.

To W. North, Guildford-place, Kennington, Surrey, surveyor, for an improved method of constructing and forming ceilings and partitions for dwelling-houses, warehouses, workshops, or other buildings, in order to render the same more secure against fire.—4th of July.—2 months.

To G. K. Sculthorpe, Robert-street, Chelsea, Middlesex, gentleman, for improvements on axles or axletrees, and coach and other springs. 4th of July.—6 months.

To J. C. Danniell, Limpley, Stoke, Bradford, Wilts, clothier, for improvements in machinery applicable to dressing woollen cloth.—8th of July.—6 months.

To W. Ramsbottom, Manchester, shape-maker, for improvements in power looms for weaving cloth.—8th of July.—6 months.

To W. Leeson, Birmingham, for improvements in harness and saddlery, part of which improvements are applicable to other purposes.—8th of July.—6 months.

To M. Poole, Lincoln's-inn, Middlesex, gentleman, for improvements in the apparatus for raising or generating steam and currents of air, and for the application thereof to locomotive engines and other purposes.—8th of July.—6 months.

To T. Salmon, Stoke-ferry, Norfolk, maltster, for his improved malt-kiln.—9th of July.—6 months.

To J. Chesterman, Sheffield, mechanic, for improvements on machines or apparatus for measuring land and other purposes.—14th of July.—6 months.

To G. Straker, South Shields, Durham, ship-builder, for an improvement in ships' windlasses.—25th of July.—2 months.

To L. Quetin, Great Winchester-street, London, professor of mathematics, for his improved vehicle, or combination of vehicles, for the carriage or conveyance of passengers and luggage.—25th of July.—6 months.

To F. H. N. Drake, esquire, Colyton-house, Devon, for improvements in tiles for covering houses and other buildings.—25th of July.—6 months.

To

To J. Nicholls, Pershall, Stafford, gentleman, for improvements in the lever, and the application of its power.—25th of July.—2 months.

To J. Bates, Bishopsgate-street, merchant, for his improved method of constructing steam-boilers or generators, whereby the bulk of the boiler, or generator, and the consumption of fuel are considerably reduced.—1st of August.—6 months.

METEOROLOGICAL OBSERVATIONS FOR AUGUST 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·36 Aug. 2. Wind S.W.—Min. 29·32 Aug. 20. Wind W.
Range of the mercury 1·04.
Mean barometrical pressure for the month .... 29·963
Spaces described by the rising and falling of the mercury............ 7·340
Greatest variation in 24 hours 0·600.—Number of changes 15.
Therm. Max. 74° Aug. 7. Wind S.E.—Min. 46° Aug. 16. Wind N.W.
Range 28°.—Mean temp. of exter. air 60°·47. For 31 days with ☉ in ♌ 61·40
Max. var. in 24 hours 19°·00—Mean temp. of spring-water at 8 A.M. 54·33

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere in the morning of the 23rd... 95°
Greatest dryness of the atmosphere in the afternoon of the 21st... 48
Range of the index 47
Mean at 2 P.M. 62°·2.—Mean at 8 A.M. 69°·3.—Mean at 8 P.M. 73·5
—— of three observations each day at 8, 2, and 8 o'clock .... 68·3
Evaporation for the month 2·85 inch.
Rain in the pluviameter near the ground 3·33 inch.
Prevailing winds, S.W. and W.

Summary of the Weather.

A clear sky, 2; fine, with various modifications of clouds, 14; an overcast sky without rain, 8; foggy, ½; rain, 6½.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
21	16	28	0	21	27	19

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
3½	½	½	3	2	8	8	5½	31

General Observations.—The first part of this month to the 12th was tolerably fine, with occasional showers and brisk winds; the remainder was wet, very stormy, and a most critical time for getting in the wheat crops in this and in the adjoining counties, but which, under difficult circumstances, has been generally effected without much injury.

The characteristics of the month being reversed to those of August in general, the state of the weather of late has become proverbial. The maximum heat in the shade here is only 74 degrees, which occurred on the 7th and 9th; and on several mornings hoar frost was seen in the grass fields before sunrise.

The mean monthly temperature of the external air is three degrees and one-fifth lower than the mean of August for the last fourteen years.

The mean temperature of September for the preceding five years, is one degree higher than that of the present month; nor have we experienced so cold, wet, and windy a summer since the memorable one of 1816; but yet it must be acknowledged that fine ripening weather has intervened, and that the copious showers having been of short duration and followed by

by brisk winds, less injury has been sustained by the crops than would otherwise have occurred.

The short summer we have had may be properly referred to the first part of June, and the latter part of July; but we only felt the glow of summer on two or three days of the former month, and the thermometer in the shade has only once reached summer heat; viz. on the 3rd of June.

The gales from the S.W. and W. on the 18th, 19th, 22nd, 23rd, and 27th instant, were scarcely ever felt stronger in this latitude; they were probably an extension of those tremendous hurricanes that are felt so powerfully at sea in the West Indies at this season of the year, but blew with the temperature of a boreas in this country in April. From this ungenial state of the weather the barley is not yet ripe in many places; and some of the wheat on low and moist lands has no doubt been damaged before it was housed; yet as the price is falling in the markets, it cannot have been much injured.

Considerable atmospherical changes have been indicated throughout the month, by the sudden elevations and depressions of the mercury in the barometer; an instrument whose workings, by means of the mutable pressure of the atmosphere, may have been consulted with advantage by agriculturists in so changeable a period.

Should the weather now set in fine, the barley and oats may yet be got in uninjured, and the corn crops generally in the northern districts be gathered in with greater facility and less trouble than in the southern.

The atmospheric and meteoric phænomena that have come within our observations this month, are one lunar and two solar halos, six meteors, three rainbows, lightning and thunder on the 19th and 27th; and twelve gales of wind, or days on which they have prevailed; namely, one from the North, one from the North-east, one from the South, five from the South-west, two from the West, and two from the North-west.

REMARKS.

London. — August 1, 2. Very fine. 3. Fine morning: stormy and wet in the afternoon. 4. Cloudy, with showers. 5. Fine. 6. Hazy and warm. 7, 8. Very fine. 9. Cloudy: sultry, with heavy rain at night. 10. Wet morning: very fine. 11, 12. Very fine. 13. Fine, with showers. 14, 15. Stormy and wet. 16. Fine. 17. Very fine: rain at night. 18—20. Cloudy, with showers. 21. Very fine. 22. Cloudy: stormy rain at night. 23, 24. Stormy and wet. 25. Very fine. 26—28. Cloudy during the day, with rain and strong gales at night. 29. Fair, but stormy. 30. Fine. 31. Cloudy.

Penzance.—August 1. Clear. 2. Clear: some rain at night. 3. Fair: misty. 4, 5. Fair. 6. Rain. 7. Clear. 8. Fair. 9. Fair: rain at night. 10. Fair: clear. 11. Clear. 12. Fair: rain at night. 13. Showers: rain at night. 14. Showers. 15. Fair. 16. Clear. 17. Fair: rain at night. 18. Rain. 19. Clear: showers. 20. Rain: fair. 21. Fair: showers. 22, 23. Rain. 24. Fair: showers. 25. Fair. 26. Rain. 27. Showers. 28, 29. Fair. 30. Clear. 31. Fair. On the 28th of this month the maximum of the register thermometer was 57°, which was lower than it had been in August for twenty-two years previous.

Boston.—August 1, 2. Fine. 3. Cloudy: rain A.M. and P.M. 4. Rain and stormy. 5. Rain. 6—9. Fine. 10. Fine: rain early A.M. 11, 12. Fine. 13. Rain. 14. Cloudy. 15. Cloudy: rain early A.M. 16. Fine: rain P.M. 17. Fine. 18. Cloudy: rain early A.M. 19. Stormy. 20. Cloudy. 21. Fine. 22. Fine: rain P.M. 23. Cloudy: rain P.M. 24. Rain: rain early A.M. 25. Cloudy. 26. Fine. 27. Stormy: rain early A.M.: rain at night. 28. Stormy. 29. Cloudy. 30. Fine. 31. Cloudy.

Meteoro-

Meteorological Observations made by Mr. BOOTH *at the Garden of the Horticultural Society at Chiswick, near London; by* Mr. GIDDY *at Penzance,* Dr. BURNEY *at Gosport, and* Mr. VEALL *at Boston.*

Days of Month, 1829.	Barometer. London. Max.	London. Min.	Penzance. Max.	Penzance. Min.	Gosport. Max.	Gosport. Min.	Boston 8½ A.M.	Thermometer. London. Max.	London. Min.	Penzance. Max.	Penzance. Min.	Gosport. Max.	Gosport. Min.	Bost. 8½ A.M.	Wind. Lond.	Penz.	Gosp.	Bost.	Evap. Gosp.	Rain. Lond.	Penz.	Gosp.	Bost.
Aug. 1	30·229	30·218	30·20	30·20	30·30	30·27	29·66	72	46	65	55	69	53	57	W.	NW.	W.	calm	...	...	...	...	...
2	30·250	30·210	30·20	30·18	30·36	30·32	29·70	75	54	67	54	69	57	61	S.	SW.	SW.	W.	...	...	...	...	...
3	30·107	29·884	30·15	30·05	30·22	29·98	29·44	64	47	65	59	67	52	63	W.	W.	SW.	W.	0·40	0·17	0·085	0·200	...
4	29·802	29·748	30·05	30·05	29·95	29·91	29·14	65	53	64	53	67	55	56·5	NW.	NW.	W.	NW.	...	·03	...	...	0·26
5	30·049	29·863	30·09	30·07	30·13	30·00	29·36	69	48	64	56	69	56	61	NW.	N.	NW.	N.	...	...	...	·035	·13
6	30·127	30·050	30·05	30·05	30·11	30·10	29·52	71	60	67	57	71	61	61·5	S.	W	W.	S.	·30	·07	·700	·015	...
☽ 7	30·201	30·157	30·15	30·15	30·[illegible]	30·17	29·57	76	52	68	54	74	57	66	SW.	N.	SE.	NE.	...	...	...	...	...
8	30·214	30·057	30·15	30·10	30·26	30·23	29·59	81	55	68	55	73	57	64	SW.	SW.	SE.	calm	...	...	...	...	...
9	30·133	29·968	30·05	30·00	30·17	30·07	29·38	74	57	69	60	74	61	66·5	S.	S.	SW.	W.	·20	·33	...	·200	...
10	29·985	29·914	30·00	29·98	30·04	29·97	29·23	72	47	66	58	70	52	63	SW.	N.	W.	W.	...	·15	·235	·100	·08
11	30·137	30·106	30·10	30·10	30·19	30·16	29·51	72	53	67	54	69	54	58	SW.	N.	N.	W.	...	...	...	...	...
12	30·111	29·941	30·08	29·95	30·16	30·05	29·60	75	59	66	53	69	60	61	S.	SE.	SE.	calm	·35	...	...	...	...
13	30·103	29·627	29·65	29·45	29·83	29·72	29·27	74	57	68	57	73	60	62	S.	SW.	SW.	E.	...	·12	·320	·300	·09
○ 14	29·482	29·417	29·65	29·35	29·52	29·48	28·98	72	52	65	57	70	51	65·5	NE.	NW.	S.	E.	...	·67	·420	·240	...
15	29·780	29·571	29·95	29·85	29·80	29·67	29·02	56	49	60	53	59	48	58	NW.	NW.	NW.	NE.	·20	·37	...	·175	·17
16	30·146	29·994	30·15	30·05	30·16	30·02	29·47	65	42	61	50	61	46	56·5	W.	NE.	NW.	N.	...	...	...	...	·05
17	30·173	30·088	30·18	30·08	30·24	30·17	29·62	70	52	64	49	65	54	[illegible]	NW.	SW.	NW.	N.	...	·17	...	...	·10
18	29·840	29·704	29·90	29·85	29·94	29·81	29·21	65	52	64	55	63	58	[illegible]	S.	W.	SW.	W.	·25	·28	·385	·220	·39
19	29·512	29·418	29·70	29·55	29·63	29·54	28·86	70	54	65	56	66	55	62	W.	W.	W.	W.	...	·08	·135	·255	...
20	29·687	29·254	29·75	29·55	29·72	29·32	28·83	65	47	62	55	65	49	56·5	NW.	NW.	W.	calm	...	·18	·250	·160	...
☾ 21	29·979	29·828	29·98	29·95	30·03	29·92	29·25	69	47	62	53	65	49	55	W.	NW.	W.	NW.	·30	...	...	...	...
22	29·935	29·634	29·75	29·65	29·98	29·74	29·35	66	56	63	52	66	60	57·5	S.	SW.	SW.	SW.	...	·48	·725	·560	...
23	29·485	29·456	29·45	29·25	29·61	29·57	28·81	69	57	65	54	66	55	56·5	W.	SW.	SW.	SW.	...	·17	·730	·295	·67
24	29·895	29·293	29·75	29·30	29·80	29·44	28·59	65	48	63	55	63	49	54	NW.	NW.	NW.	W.	·20	·19	·230	·030	·91
25	30·082	29·899	30·05	29·98	30·16	30·00	29·22	66	40	66	53	65	48	55	W.	NW.	W.	W.	...	...	...	...	·06
26	30·056	29·594	29·85	29·65	30·10	29·75	29·45	66	56	64	54	67	55	58	S.	S.	S.	W.	...	·06	·250	·100	...
27	29·640	29·293	29·85	29·70	29·74	29·60	28·92	67	50	62	54	65	53	58·5	W.	W.	W.	W.	·25	·37	·050	·410	·13
28	29·759	29·555	29·97	29·95	29·84	29·65	28·90	63	54	57	52	63	52	55·5	NW.	N.	NW.	N.	...	·11	...	·020	·35
● 29	30·157	29·891	30·12	30·10	30·17	29·93	29·44	66	51	60	54	65	52	60	N.	N.	N.	NE.	...	·03	...	...	...
30	30·203	30·134	30·22	30·22	30·26	30·22	29·54	65	52	61	53	62	52	56	NE.	NE.	N.	N.	...	...	...	·015	...
31	30.090	30·040	30·12	30·10	30·17	30·10	29·51	62	54	65	56	64	54	56	NE.	NE.	N.	NE.	·40	·04	...	...	...
Aver.	30·250	29·254	30·22	29·25	30·36	29·32	29·28	81	40	69	49	74	46	59·5					2·85	4·07	5·515	3·330	3·39

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

NOVEMBER 1829.

LI. *On the Deviation of a Falling Body from the Vertical to the Earth's Surface.* By W[illegible] G[illegible]ITH, *Esq.*

To the Editors of the Philosophical Magazine and Annals.

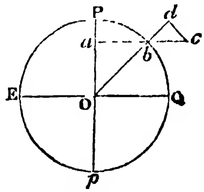
Gentlemen,

THE problem of determining the deviation of a body from the vertical to the earth's surface at a given point when let fall from another given point above it, has exercised the talents of the greatest mathematicians. Emerson in this country, and Laplace in France, have successively considered it, and given solutions;—the former in his *Algebra*, problem 198; the latter in the *Bulletin des Sciences*, No. [illegible]5.

The solutions are obtained on the supposition of the earth being a sphere, which may be considered sufficiently accurate; since the difference for the spheroidal figure would in this case be quite insensible. Indeed, the difference of effect arising from the centrifugal force being derived from the ordinate to the polar axis of a spheroid of small eccentricity, such as the earth, instead of the cosine of the latitude to radius unity, must be very slight. The ratio of the centrifugal to gravity at the equator is expressed by $\frac{r}{r+\left(\frac{t}{2}\right)^2 p}=f$, (Phil. Mag. Old Series, vol. lxiv. p. 163). Now if r be the radius of the equator, it will be (Phil. Mag. vol. ii. New Series, p. 54.) 20921178 feet. But if r be the radius of the inscribed sphere, it will be 20853184 feet: and taking p, the length of the pendulum, at 3·2511 feet, we should have $f = 0·003455$ in the one case, and $f' = 0·003444$ in the other, or about $\frac{1}{289\frac{1}{2}}$ and $\frac{1}{290}$ respectively.

Hence the difference of the effects of centrifugal force in the case of the earth being a spheroid instead of a sphere is very small. The effect of the centrifugal force at the equator being about $\frac{1}{288}$ of that of gravity, it decreases on approaching the poles upon the whole, though the direction becomes most favourable at 45° for thowing a body towards the poles, thus making it deviate slightly from a due east course.

Let P E p Q be a section of the earth considered a sphere, P p the polar axis, and E Q the equator; then O Q : $a\,b$: : the centrifugal force at Q : to the centrifugal force at b. But O Q : $a\,b$: : radius : cosine of the latitude, or the centrifugal force at the equator is to the centrifugal force at any latitude as radius is to the cosine of that latitude.



Again, $Ob : ab :: bc : bd = \frac{ab \times bc}{Ob}$. As O b is constant, $b\,d$ varies as $a\,b \times b\,c$. But $b\,c$ varies as $a\,b$; therefore $b\,d$, that part of the centrifugal acting in opposition to gravity, varies as $a\,b^2$, or as the square of the cosine of the latitude. In like manner $Ob : Oa :: bc : cd = \frac{Oa \times bc}{Ob}$ and since O b is constant, $c\,d$ varies as $O\,a \times b\,c$. But $b\,c$ varies as $a\,b$, or as the cosine of the latitude, and O a as the sine; consequently that part of the centrifugal force, at right angles to the direction of gravity, tending to move the body nearer the poles than the point directly under that from which it was dropt, varies as the product of the sine into the cosine of the latitude.

Let x be the sine, then $\sqrt{1-x^2}$ is the cosine, therefore $c\,d$ will be a maximum when $x(1-x^2)^{\frac{1}{2}}$ is a maximum, or when the latitude is 45°, and then sin × cos = 0·5 or $\frac{1}{2}$. But $\frac{1}{2} \times \frac{1}{288\frac{1}{2}} = \frac{1}{577}$; therefore the maximum effect of centrifugal force to throw the body towards the poles is only $\frac{1}{577}$ of the effect of gravity. Hence if Δ denote the deviation directly eastward arising from the earth's rotation combined with the action of gravity, then the deviation northward or southward from the effects of centrifugal force will be expressed by

$\Delta \times f \times \sin\lambda \times \cos\lambda$ .... (a)

in which λ is the latitude.

Let $d = \Delta \times f \times \sin\lambda \times \cos\lambda$, then by the composition of forces $D = \sqrt{\Delta^2 + d^2}$, as the triangle so formed, having the hypothenuse the diagonal of the parallelogram, is a right-angled

gled plane triangle, and consequently the amplitude towards the north or south of east may be readily obtained.

If the heavy body fall an English mile or 5280 feet in the latitude of London, Δ will be 2·89 feet only, and $\sin\lambda \times \cos\lambda = 0{\cdot}4872$; whence

$d = 2{\cdot}89 \times 0{\cdot}4872 \times 0{\cdot}0035 = 0{\cdot}0049$ or $0{\cdot}005$ nearly, and $D = \sqrt{8{\cdot}3521 + 0{\cdot}000025} = 2{\cdot}8900045$. Consequently d^2 has almost no effect to increase D, while the direction must likewise be nearly due east, and therefore both these corrections may in every case be omitted.

Emerson gives $D = \dfrac{2\,d\,m\,p}{3r+m}$ .... (1)

in which D is the deviation, $d = \dfrac{2rc}{t}\sqrt{\dfrac{m}{f}}$; m, the given height fallen through; p, the cosine of the latitude; r, the radius of the earth; c, 3·141593, the circumference of a circle to diameter unity; t, the time of the rotation of the earth about it saxis; and $f = \frac{1}{2}g = 16{\cdot}1$ feet; consequently if the formula be written at full length it becomes

$$D = \frac{2}{3r+m} \times \frac{2rc}{t} \times m \times p\sqrt{\frac{m}{f}} \;\ldots\ldots\ldots\ldots\; (2)$$

which evidently is far from being convenient in practice.

Since the quantity m must in general be very small in comparison with $3r$, it may be neglected without sensible error, and then

$$D = \frac{2}{3} \times \frac{2c}{t} \times m \times p\sqrt{\frac{m}{f}} \;\ldots\ldots\ldots\ldots\; (3)$$

If in this formula we write Δ for D, h for m, $\sin\theta$ for p, and n for $\frac{2c}{t}$, equation (3) becomes

$$\Delta = \frac{2}{3}\, n\, h \sin\theta \sqrt{\frac{2h}{g}} \;\ldots\ldots\ldots\ldots\; (4)$$

which is the formula of Laplace given in the *Bulletin des Sciences*, No. 75, and is therefore almost identical with that of Emerson published in his *Algebra* many years before.

It appears that the formula may be very simply obtained in the following manner. Let a be the altitude in feet from which the body is let fall, r the radius of the equator, or even the mean radius of the earth, and π the circumference of a circle to diameter unity.

The circumference of a circle at the height a is

$$2\pi(r+a) = 2\pi r + 2\pi a$$

at the surface ...... $2\pi \times r \quad = 2\pi r$

Difference, or Δ .... $= \quad 2\pi a$ .... (5)

the distance which a point at the height a describes more than at the surface during one rotation of the earth.

 By

By dynamics $s = \frac{1}{2} g t^2$, or in this case $a = \frac{1}{2} g t^2$, therefore $t = \sqrt{\frac{a}{\frac{1}{2} g}}$ . . . . (6)

The earth performs a rotation about its axis in $23^h\ 56^m\ 4^s$ or 86,164 seconds. Let this be represented by ϱ; whence

$$\varrho : 2\pi a :: \sqrt{\frac{a}{\frac{1}{2}g}} : \delta = \frac{2\pi}{\varrho} a \sqrt{\frac{a}{\frac{1}{2}g}} = \frac{2\pi}{\varrho}\sqrt{\frac{a^3}{\frac{1}{2}g}} \ldots \quad (7)$$

the difference between the arcs in the time of fall. But the body in falling describes a small portion of an ellipse, which on account of its minuteness may be considered parabolic, as shown in our ordinary treatises on Natural Philosophy, (Leslie's, vol. i. p. 128.) of which the contained area is two-thirds of the circumscribing rectangle; wherefore,

$$D = \frac{2}{3} \times \frac{2\pi}{\varrho} \times \sqrt{\frac{a^3}{\frac{1}{2}g}} \ldots\ldots\ldots \quad (8)$$

This formula gives the deviation at the equator. In a given latitude λ from what precedes,

$$D = \frac{2}{3} \times \frac{2\pi}{\varrho} \times \cos\lambda \sqrt{\frac{a^3}{\frac{1}{2}g}} = \frac{4\pi}{3\varrho} \cos\lambda \sqrt{\frac{a^3}{\frac{1}{2}g}} \ldots \quad (9)$$

Let $\frac{4\pi}{\varrho} = k$, and formula (9) becomes

$$D = k \cos\lambda \sqrt{\frac{a^3}{\frac{1}{2}g}} \ldots\ldots\ldots\ldots \quad (A)$$

As it requires a fall of a considerable number of feet to produce a sensible change in the deviation, $\frac{1}{2} g$ may be taken at 16 feet, which introduced into formula (9) gives

$$D = \frac{\pi}{3\varrho} \cos\lambda\ a^{\frac{3}{2}}$$

Now, calling $\frac{\pi}{3\varrho} = K$, we shall have, finally,

$$D = K \cos\lambda\ a^{\frac{3}{2}} \ldots\ldots\ldots\ldots \quad (B)$$

an expression remarkably simple.

This formula is well adapted for logarithmic calculation, in which case it will become

$$\text{Log. } D = \text{const. log. } 5\cdot084702 + \text{log. } \cos\lambda + \tfrac{3}{2} \text{ log. } a \ldots \quad (C)$$

Let Emerson's example be solved by this formula, in which a is 5280 feet, and λ is 51° 30′.

Constant logarithm	5·084702
λ = 51° 30′ N. log. cosine . . .	9·794150
a = 5280 feet logarithm	3·722634
half same log.	1·861317
D = 2·9026 feet (Sum)	0·462803

This result differs in a slight degree from Emerson's, which is 2·88 feet; but the difference may be accounted for by his taking

taking 21,000,000 feet for the radius of the earth, instead of 20,920,000. This is involved in his solution, as well as the assumption that the earth performs a rotation in twenty-four hours instead of $23^h\ 56^m\ 4^s$, which in conjunction will produce the slight effect just noticed. I am yours, &c.

Edinburgh, Oct. 1, 1829. WILLIAM GALBRAITH.

LII. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. CHILDREN, *F.R.S. L. & E. F.L.S. &c.*

[Continued from page 296.]

Genus 88. ENNOMOS, *Ochs., Treitsch.*

(ENNOMOS, GEOMETRA, PERICALLIA, BRADYPETES, MACARIA, Stephens. MACARIA, Curtis. ENNOMOS, AVENTIA, PHILOBIA, TIMANDRA, EPIONE, EURYMENE, RUMIA, ANGERONA, Duponchel.)

Wings not, or scarcely at all, deflexed when at rest; the *inferior* with a prominent angle at the posterior margin; the underside generally ornamented with lively colours.—*Larva*, with the body tubercular, tapering towards the head, which is prominent, rather broad, and depressed.—*Pupa* folliculated, not subterranean; generally changes in a slight web attached to the leaves of plants.

Obs. The preceding long list of synonyms shows sufficiently the concurrent opinions of many authors as to the necessity of breaking down this genus into several new ones; and M. Treitschke himself seems to admit their accuracy, since he has adopted no less than five families or subdivisions to receive the species, according to the form of the wings, their markings, &c. demonstrating how inefficient, even in his own estimation, are the very meagre characters which (as above) he has prefixed to the genus.

FAM. A. — Fore wings horizontally extended,—hind wings rounded.

FAM. B.—Fore wings extended,—hind wings angular.

FAM. C.—All the wings indented.

FAM. D.—Crescent-shaped markings or maculæ on the disc of the fore wings.

FAM. E.—All the wings indented,—the dentations of the fore wings particularly strong.

We shall, as usual, give the characters of the new genera (if published) in foot-notes, as the respective species occur on which

which they have been established; *and as we are now* entering on the PHALÆNIDÆ, (PHALÆNITES, Latr.) we shall also in this place insert the characters of that tribe, as given in the beautiful and eminently useful work begun by the late M. Godart, and, since his death, continued with increasing ability and excellence by his successor M. Duponchel.

PHALÆNIDÆ.

This tribe was originally composed of the true Phalænæ, or Geometræ, and those species which M. Latreille has since separated from them under Laspeyre's genus Platypteryx: the following characters apply therefore solely to the former.

Wings entire, or without fissures, generally of a slighter texture, and larger in proportion to the body than those of the BOMBYCIDÆ or NOCTUIDÆ, horizontally extended, or scarcely deflexed, when at rest; no orbicular or reniform spots (the usual distinguishing markings of the Noctuidæ) on the upper wings; the lower wings very little folded at the internal margin when hid by the upper.—*Antennæ* setaceous, sometimes simple* in both sexes, sometimes pectinated or ciliated, in the males.—*Lower palpi* always covering the *upper*, in form pretty constant, often very velvety, and very little, or not at all porrected beyond the head.—*Maxillæ* more frequently membranous than horny, in the greater part of the species more or less projecting, but almost or altogether wanting in the rest.—*Thorax* more frequently velvety than squamous, never crested, nor tufted.—*Abdomen* generally long and slender, except in certain females.—*Larva* naked or only furnished with a few short hairs; always *loopers*, whatever the number of *feet*, which varies from ten to fourteen, including the anal, which are never wanting; the six anterior, and four posterior feet only, used in walking.—*Metamorphosis* very various.—*Duponch. Lep. de France, tom.* vii. *part.* ii. p. 97.

	Species.	Icon.
FAM. A.		
	1. Enn. *Flexularia*, Hübn...	Ernst, V. pl. ccx. f. 280. a. b.
	2. — *Cordiaria*, Hübn.......	Hübn. Geom. tab. 8. f. 38. (mas.)
		tab. 66. f. 342. (fœm.)
	3. — *Adspersaria*, Hübn....	Hübn. Geom. tab. 39. f. 206. (mas.)
FAM. B.		
	4. Enn. *Notataria*, Hübn.†.	Hübn. Geom. tab. 11. f. 53. (mas.)
		tab. 61. f. 316. (fœm.)

5. Enn.

* As seen by the naked eye: examined with a lens they never appear simple or filiform.—*Dup.*

† PHILOBIA, Duponch.—"*Antennæ* slightly pectinated in the males, and simple

Species.	Icon.
5. Enn. *Lituraria*, Hübn.*..	Hübn. Geom. tab. 11. f. 54. (mas.) tab. 61. f. 314. (fœm.) Curtis, Brit. Ent. III. pl. 132.
6.—*Signaria*, Hübn.	Hübn. Geom. tab. 61. f. 313. (fœm.)
7.—*Alternaria*, Hübn. ...	Hübn. Geom. tab. 61. f. 315. (fœm.)
8.—*Æstimaria*, Hübn.	Hübn. Geom. tab. 64. f. 333. (fœm.)
9.—*Amataria*, Linn.†	Hübn. Geom. tab. 10. f. 52. (mas.)
10.—*Imitaria*, Hübn.†	Hübn. Geom. tab. 10. f. 51. (mas.)
11.—*Strigillata*, Lasp.	Hübn. Geom. tab. 20. f. 109. (fœm.)
12.—*Emutaria*, Hübn.†	Hübn. Geom. tab. 63. f. 323. (mas.)
FAM. C.	
13. Enn. *Emarginaria*, Hüb.‡	Hübn. Geom. tab. 20. f. 107. (mas.)
14.—*Flavicaria*, Hübn......	Hübn. Geom. tab. 8. f. 40. (mas.)
15.—*Parallelaria*, Hübn....	Hübn. Geom. tab. 9. f. 43. (mas.) f. 44. (fœm.)

simple in the females.—*Thorax* narrow, but slightly velvety.—*Anterior wings* slightly emarginate below the superior angle; middle of the margin of the *lower wings* forming a more or less acute angle.—*Palpi* convergent at the extremity, porrected beyond the head.—*Larva* smooth, not tuberculated, somewhat attenuated anteriorly; *head* small, cordiform.—*Metamorphosis* occurs amongst leaves or moss at the foot of trees, according to the season."—*Duponchel, Lep. de France, tom.* vii. *part.* ii. p. 195.

Duponchel refers seven species (all taken from Treitschke's genus Ennomos,) to his genus Philobia, grouping them according to the ground colour of the wings, and the upper being with or without emarginations.—Ground yellow, *Ph. flavicaria.*—Ground gray, with the upper wings distinctly emarginate.—*Cordiaria, notataria, alternaria, lituraria.*—Gray, with no emargination in the upper wings,—*signaria, æstimaria.*

* MACARIA, Curtis.—Curtis suggests the propriety of dividing the Phalænidæ into two families, calling those species whose males have the antennæ pectinated *Geometridæ,* and the rest, or those with simple antennæ in both sexes, *Phalænidæ.* His genus Macaria belongs to the latter group.

† TIMANDRA, Duponch.—"*Antennæ* in the males pectinated, in the females simple.—*Thorax* narrow, slightly velvety. Superior angle of the *upper wings* very acute; middle of the margin of the lower projecting to a point. *Palpi* porrected beyond the head, last joint very slender and acuminated.—*Maxillæ* rather long.—*Larva* not tuberculated, anteriorly clavate.—*Pupa* angular, enveloped in a slight web amongst leaves."—*Lep. de France, tom.* vii. *part.* ii. p. 224.

The three species composing this genus, are readily known by the band which traverses all the wings diagonally, and by the well defined angle formed by the middle of the lower wings.

‡ EPIONE, Duponch.—"*Antennæ* pectinated or ciliated in the males, simple in the females.—*Thorax* narrow, slightly velvety.—*Lower wings* with the terminal margin more or less emarginate, or sinuous.—*Palpi* very distinct, porrected beyond the head.—*Maxillæ* long.—*Larva* covered with fine, insulated hairs, not tuberculated, attenuated anteriorly from the sixth segment; *head* small, square.—*Metamorphosis* in leaves united by silken threads."—*Lep. de France, tom.* vii. *part.* ii. p. 211.—Four species are assigned to this genus by its author; *apiciaria* and *parallelaria,* which have all the wings terminated by a broad band,—and *advenaria* and *emarginaria,* which want the terminal band.

16. Enn.

Species.	Icon.
16. Enn. *Apiciaria*, Hübn....	Hübn. Geom. tab. 9. f. 47. (mas.)
17.—*Advenaria*, Hübn......	Hübn. Geom. tab. 9. f. 45. (mas.)
18.—*Dolabraria*, Linn.*. ...	Hübn. Geom. tab. 8. f. 42. (fœm.)
FAM. D.	
19. Enn. *Cratægata*, Linn. †..	Hübn. Geom. tab. 6. f. 32. (fœm.)
20.—*Prunaria*, Linn..‡......	Hübn. Geom. tab. 23. f. 122. (fœm.) f. 123. (mas.)
21.—*Syringaria*, Linn. §.....	Hübn. Geom. tab. 6. f. 29. (fœm.)
22.—*Lunaria*, Fab. §	Hübn. Geom. tab. 7. f. 33. (mas.) f. 34. (fœm.)
23.—*Illunaria*, Hübn. §	Hübn. Geom. tab. 7. f. 36. (mas.) f. 37. (fœm.)
24.—*Illustraria*, Hübn. § ...	Hübn. Geom. tab. 7. f. 35. (mas.)
25.—*Pectinaria*, Hübn. § ...	Hübn. Geom. tab. 6. f. 30. (mas.)
FAM. E.	
26. Enn. *Evonymaria*, Hübn. §	Hübn. Geom. tab. 6. f. 31. (mas.) tab. 83. f. 428. (fœm.)
27.—*Angularia*, Hübn. §.....	Hübn. Geom. tab. 5. f. 22. (mas.)
28.—*Erosaria*, Hübn. §	Hübn. Geom. tab. 5. f. 25. (mas.)
29.—*Dentaria*, Hübn. §......	Hübn. Geom. tab. 3. f. 12. (fœm.)
30.—*Alniaria*, Linn. §........	Hübn. Geom. tab. 5. f. 26. (fœm.)
31.—*Tiliaria*, Hübn. §	Hübn. Geom. tab. 5. f. 23. (mas.)

Genus

* EURYMENE, Duponchel.—" *Antennæ* pectinated in the males, simple in the females.—*Thorax* narrow, slightly velvety.—*Upper wings* narrow in proportion to the lower, square at the extremity.—*Palpi* thick, scarcely porrected beyond the head.—*Maxillæ* long.—*Larva* with the second and eighth segments tuberculated; *head* slightly emarginate superiorly.—*Metamorphosis* in a slight web amongst leaves."—*Lep. de France, tom.* vii. *part.* ii. p. 185.—One species only.

† RUMIA, Duponch.—" *Antennæ* simple in both sexes.—Terminal margin of the lower wings obtusely angular in the middle.—*Palpi* with the last joint very short, scarcely extending beyond the head.—*Maxillæ* long, rather thick at the base.—*Larva* elongate, cylindrical; *head* round; a very projecting tubercle on the sixth segment.—*Metamorphosis* in a slight web amongst leaves."—*Lep. de Fran. tom.* vii. *part.* ii. p. 117.—Only one species.

‡ ANGERONA, Duponch.—" *Thorax* narrow, slightly velvety.—*Lower wings* only slightly denticulated, with the terminal margin emarginate.—*Palpi* very slender, not extended to the forehead.—*Maxillæ* long.—*Antennæ* in the males strongly pectinated, simple in the females.—*Larva* attenuated anteriorly; *head* small, prominent, fourth and eighth segments tuberculated.—*Metamorphosis* in a slight web amongst leaves."—*Lep. de France, tom.* vii. *part.* ii. p. 180.—Only one species.

§ ENNOMOS, Duponch.—" *Antennæ* pectinated in the males, simple in the females.—*Thorax* broad and very velvety.—*Wings* indented.—*Palpi* somewhat inclined, and extending beyond the forehead.—*Maxillæ* slender, scarcely exceeding the palpi.—*Larva* more or less elongated, and resembling, in form and colour, the twigs of a tree, their body being covered at

Genus 89. ACÆNA, *Ochs.*, *Treitsch.*

(Ourapteryx, Leach, Samouelle, Stephens, Duponchel. Urapteryx, Kirby.)

Wings, upper angle of the *superior* very acute; *inferior* with the middle of the terminal margin truncato-caudate.—*Palpi*, last joint very small, not surpassing the forehead, which is broad and velvety.—*Maxillæ* very long*.

Species.	Icon.
1. Ac. *Sambucaria*, Linn. ...	Hüb. Geom. tab. 6. f. 28. (fœm.)

Genus 90. ELLOPIA, *Ochs.*, *Treitsch.*

(Ellopia, Phalæna, Stephens. Metrocampe, Latreille, Duponchel.)

Wings angular or rounded; the upper always with two transverse bands, and the lower with a single one, exactly corresponding with that nearest the terminal margin on the upper.—*Antennæ* pectinated in the males, simple in the females.—*Palpi* slender, scarcely surpassing the forehead.—*Maxillæ* long.—*Larva* naked, occasionally with a few scattered short hairs; *body* elongate, flattened beneath; *head* obtuse, rounded.—*Metamorphosis* in a thin web on the ground, under the surface on trees, or amongst leaves*.

Both Treitschke and Duponchel divide the four species of which this genus consists into two groups: the first having the wings angular (Fam. A. *Treitsch.*); the second rounded (Fam. B. *Treitsch.*)—Duponchel states that M. Latreille formed this genus, under the name of *Metrocampe*, two years before M. Treitschke gave it that of Ellopia. He

at intervals with excrescences like knots or buds.—*Head* depressed, slightly emarginate on the upper part, and not surpassing the first segment.—*Metamorphosis* usually in a slight web amongst leaves."—*Lep. de Fran. tom.* vii. *part.* ii. p. 136.

M. Duponchel adds that the species of this genus are generally fulvous-yellow, rather large, and carry their wings vertically, when at rest, like the diurnal Lepidoptera, exhibiting distinctly the underside, which is more vividly coloured than the upper. The larvæ are principally found in May and June: in July and August the perfect insect comes forth, and is principally met with in woods, but the species *Syringaria* and *Evonymaria* prefer cultivated gardens. The females are heavy and sluggish, and seldom quit the tree on which they came forth; the males are very active, and in continual flight, even during the day-time. Duponchel divides the species into three groups: 1st group, all the wings denticulated; no crescent-shaped marking at the summit of the upper; *alniaria, tiliaria, angularia, erosaria, dentaria.*—2nd group, all the wings denticulated; a crescent at the summit of the upper; *lunaria, illunaria, illustraria.*—3rd group, the wings rather sinuated than denticulated; *syringaria, evonymaria, pectinaria.*

* Characters from Duponchel.

consequently very properly retains the former, and rejects the latter appellation.

Fam. A.	Species.	Icon.
1. Ell. *Honoraria*, Hübn.	.....	Hübn. Geom. tab. 3. f. 16. (mas.)
2.—*Margaritaria*, Hübn.	...	Hübn. Geom. tab. 3. f. 13. (fœm.)
Fam. B.		
3. Ell. *Prasinaria*, Hübn.	....	Hübn. Geom. tab. 1. f. 4. (mas.)
4.—*Fasciaria*, Linn.	....	Hübn. Geom. tab. 1. f. 5. (mas.) tab. 87. f. 447. (fœm.)

Genus 91. GEOMETRA, *Ochs.*, *Treitsch.*

(Hipparchus, Stephens.
Hemithea, Geometra, Duponchel.)

Wings with one or more transverse, wavy, white lines or bands; generally of a very light green, or whitish green colour.—*Larva* usually green, sometimes mixed with reddish-brown; *head* and first segment of the body with two small reddish tubercles.—*Metamorphosis* in a thin, transparent web.

Fam. A.—Posterior wings angular.

Fam. B.—Posterior wings rounded.

Obs. Such are M. Treitschke's generic characters by which his Geometræ are to be distinguished, the chief of which consists in the ground-colour of the wings being green! —Well may M. Duponchel exclaim (*Lep. de Fran. tom.* vii. *part.* ii. p. 256) "how could he establish a *genus* on a character which is not even specific? for we see species varying from green to red. It is not so as to the principal markings of the wings (putting their colour out of the question), for their relation to the rest of the organization has always appeared to us to be constant; and we have not hesitated to adopt them as generic characters, whenever we have been unable to discover others in the perfect insect." We are not quite sure that we agree with M. Duponchel in the latter part of his observation; but whatever comes from the pen of such distinguished authority, must at least command attention and respect.

Fam. A.	Species.	Icon.
1. Geom. *Vernaria*, Linn.*		Hübn. Geom. tab. 2. f. 7. (fœm.)

2. Geom.

* Hemithea, Duponch.—"*Antennæ* pectinated in the males, simple in the females.—*Thorax* narrow, slightly velvety.—Upper angle of the *anterior wings* more or less acute; middle of the terminal margin of the *posterior* in most species, pointed.—*Palpi* slender, extending beyond the forehead. —*Maxillæ* prominent.—*Larva* smooth, elongated; *head* deeply bifurcate; anterior

Species.	Icon.
2. Geom. *Papilionaria*, Linn.*	Hübn. Geom. tab. 2. f. 6. (fœm.)
3.—*Viridata*, Linn.........	Hübn. Geom. tab. 2. f. 11. (mas.)
4.—*Æruginaria*, Hübn....	Hübn. Geom. tab. 9. f. 46. (mas.)
5.—*Putataria*, Linn........	Hübn. Geom. tab. 2. f. 10. (fœm.)
6.—*Bupleuraria*, Hübn....	Hübn. Geom. tab. 2. f. 8. (mas.)
7.—*Æstivaria*, Hübn......	Hübn. Geom. tab. 2. f. 9. (fœm.)
FAM. B.	
8. Geom. *Cythisaria*, Hübn..	Hübn. Geom. tab. 1. f. 2. (mas.)
9.—*Bajularia*, Hübn.......	Hübn. Geom. tab. 1. f. 3. (mas.)
10.—*Smaragdaria*, Fab.	Hübn. Geom. tab. 1. f. 1. (fœm.)
(11.—*Agrestaria*, Duponch.	Duponch. Lep. de Fr. vii. pl. 152. f. 4.) (fœm.)

Genus 92. ASPILATES, *Ochs.*, *Treitsch.*

(ASPILATES, PHASIANE, Duponchel.
ASPILATES, PHIBALAPTERYX, LOZOGRAMMA, Stephens.)

Wings, *anterior* with three almost straight, transverse, diagonal bands, dividing the area into as many nearly equal compartments: *posterior* with faint traces of the outer bands.—*Larva*, not tubercular, except two small elevations on the last segment, somewhat attenuated anteriorly.—*Metamorphosis* above ground.

anterior margin of the first segment with one or two points inclined towards the head.—*Metamorphosis* in a slight web amongst leaves."—*Lep. de Fran. tom.* vii. *part.* ii. p. 233.

M. Duponchel adds that these insects are at once distinguished by their delicate green colour and the two white bands on the wings, which however are only secondary characters. It was the peculiar form of the larvæ that determined him to create the genus Hemithea, for those species which he places in it, and which he arranges in three groups: 1. Lower wings angular; fringe of two alternating colours; *bupleuraria, æstivaria.*—2. Lower wings angular, fringe of one colour; *putataria, æruginaria, viridaria, vernaria.*—3. Lower wings rounded; *smaragdaria, gemmaria, coronillaria, agrestaria.*

The following caution of M. Duponchel may be useful to young collectors:—"Be careful to *set* all the species of this genus *before they become rigid;* for their fine green colour becomes white or yellowish by damping."

* GEOMETRA, Duponch.—"*Antennæ* pectinated in the males, simple in the females.—*Thorax* narrow, slightly velvety.—*Lower wings* only, slightly denticulated.—*Palpi* straight, extending beyond the forehead; last joint naked, very distinct.—*Maxillæ* not prominent.—*Larva* short, cylindrical; *head* rounded; the middle segments tubercular.—*Metamorphosis* in a transparent cocoon, amongst leaves."—Duponch. *Lep. de Fran. tom.* vii. *part.* ii. p. 259.

The species *papilionaria* and *bajularia* are the only ones which M. Duponchel includes in this genus.

Species.	Icon.
1. Asp. *Purpuraria*, Linn.*	Hübn. Geom. tab. 38. f. 198. (mas.) f. 199. (fœm.)
2.—*Mundataria*, Cram. ...	Hübn. Geom. tab. 72. f. 375. (mas.)
3.—*Sacraria*, Linn.........	Hübn. Geom. tab. 38. f. 200. (mas.)
4.—*Gilvaria*, Fab.†.........	Hübn. Geom. tab. 38. f. 201. (fœm.)
5.—*Arenacearia*, Hübn....	Hübn. Geom. tab. 21. f. 114. (mas.)
6.—*Cruentaria*, Hübn......	Hübn. Geom. tab. 10. f. 48. (mas.)
7.—*Vespertaria*, Linn......	Hübn. Geom. tab. 45. f. 226. (mas.)
8.—*Citraria*, Hübn.........	Hübn. Geom. tab. 40. f. 212. (mas.)
9.—*Artesiaria*, Fab.........	Hübn. Geom. tab. 3. f. 15. (fœm.)
10.—*Coarctata*, Fab.........	Hübn. Geom. tab. 42. f. 219. (fœm.)
11.—*Lineolata*, Hübn.‡....	Hübn. Geom. tab. 60. f. 311. (mas.)
12.—*Palumbaria*, Fab.§.....	Hübn. Geom. tab. 42. f. 221. (fœm.)
13.—*Petraria*, Hübn.‖......	Hübn. Geom. tab. 21. f. 113. (mas.)

Genus 93. CROCALLIS, *Ochs.*, *Treitsch.*

(Crocallis, Himera, Duponchel.
Crocallis, Metra, Stephens.)

Antennæ in the males strongly pectinated, nearly plumose.—*Anterior wings* with two transverse bands, converging towards the interior margin.—*Abdomen* remarkably stout, especially in the females.—*Larva* very thick in proportion to its length.—*Metamorphosis* above ground, or just under the surface in a slight web.

Species.	Icon.
1. Croc. *Extimaria*, Hübn.¶	Hübn. Geom. tab. 4. f. 21. (mas.)

* Aspilates, Stephens.

† Aspilates, Duponch.—"*Anterior wings* traversed diagonally by one or two lines springing from the superior angle; *posterior wings* of nearly the same form as the anterior.—*Palpi* pointed, extending beyond the forehead.—*Legs* very long.—*Maxillæ* very distinct."—*Lep. de France, tom.* vii. *part.* ii. p. 108.

‡ Phibalapteryx, Stephens.

§ Aspilates, Stephens. Phasiane, Duponch.—"Ph. *Anterior wings* with a dot between two transverse, nearly straight, and almost parallel lines.—*Palpi* pointed, extending beyond the forehead.—*Maxillæ* long."—*Lep. de France, tom.* vii. *part.* ii. p. 109.

‖ Lozogramma, Stephens.

¶ Crocallis, Duponch.—"All the *wings* slightly indented, with a point in the centre of each, two transverse, diverging lines on the *anterior*, and a single line on the *posterior*.—*Palpi* with the last joint pointed, extending beyond the forehead.—*Maxillæ* none.—*Thorax* wide, very velvety.—*Antennæ* pectinated in the males; simple in the females.—*Larva* rugose, of equal thickness through its whole length, not tubercular, but with a few short, scattered hairs: *head* as large as the first segments, slightly depressed anteriorly."—*Lep. de France, tom.* vii. *part.* ii. p. 174.

2. Croc.

Species. Icon.

2.Cro.*Elinguaria*, Linn.*...Hübn. Geom. tab. 4. f. 20. (fœm.)
3.—*Pennaria*, Linn. †......Hübn. Geom. tab. 3. f. 14. (mas.)

Genus 94. GNOPHOS, *Ochs.*, *Treitsch.*

(Gnophos, Hemithea, Duponchel.
Charissa, Curtis, Stephens.)

Wings dusky, blackish or cinereous, with indistinct transverse bands; *posterior* slightly indented.—*Larva* smooth, cylindrical.—*Metamorphosis* subterranean.

Species. Icon.

1.Gnop.*Furvata*, Fab.‡.....Hübn. Geom. tab. 27. f. 144.(mas.)
2.—*Dumetata*, Treitsch.§ — — —
3.—*Obfuscata*, Wien. Verz. Hübn. Geom. tab. 27. f. 142. (fœm.)
4.—*Perspersata*, Treitsch.. Hübn. Geom. tab. 79. f. 406.(fœm.)
5.—*Obscurata*, Wien. Ver. ‖ Hübn. Geom. tab. 27. f. 146.(mas.)
6.—*Coronillaria*, Hübn.¶ Hubn. Geom. tab. 93. f. 479. 480. (mas.) f. 481. 482. (fœm.)
7.—*Serotinaria*, Hübn.‖...Hübn. Geom. tab. 28. f. 147.(fœm.)
8.—*Dilucidaria*, Hübn. ...Hübn. Geom. tab. 27. f. 143.(mas.)
(8*—*Operaria*, Hübn.‖......Hübn. Geom. tab. 69. f. 359. Curtis, Brit. Ent. iii. pl. 105.)

* Crocallis, Duponchel, Stephens.

† Metra, Stephens. Himera, Duponch.—"*Thorax* and *wings* as in Crocallis.—*Palpi* very velvety, not extending beyond the forehead.—*Maxillæ* very distinct, though slender.—*Antennæ* plumose in the male, simple in the female.—*Larva* smooth, cylindrical, not tubercular: *head* small, rounded; two fleshy points, inclined towards the anus, on the penultimate segment."—*Lep. de France, l. c. supra*, p. 169.

‡ Gnophos, Duponch.—"Fringe of all the *wings* more or less indented or festooned; *superior* traversed by two indented lines, the *inferior* by only one; an orbicular spot in the centre of each wing.—*Body* long and slender.—*Palpi* short, obtuse.—*Maxillæ* long."—*Lep. de France, tom.* vii. *part.* ii. p. 110.

§ Gnop. alis dentatis cæruleo-fuscis, margine externo obscuriore, striis punctatis nigris.—*Ochs. Treitsch. tom.* vi. *pars* i. p. 163.

‖ Charissa, Curtis.—"*Antennæ* arising from the back part of the head, rather robust, long, attenuated at both ends, composed of numerous transverse joints, with a few short scales above, hairy beneath, compressed and produced internally in the males, slender and setaceous in the females.—*Labrum* and *mandibles* minute, the latter ciliated internally.—*Maxillæ* long, ciliated towards their extremity.—*Labial palpi* not so long as the head, nearly straight, not projecting like a beak, nor contiguous, sparingly covered with scales, 3-jointed.—*Head* small, covered with short close scales.—*Wings*, *superior* trigonate, apex acute, margins indented, especially in the *inferior*.—*Abdomen* long, slender and obtuse in the males, shorter and subconic in the females."—*Brit. Ent. l. c. supra.*

¶ Hemithea, Duponch. (*vide supra, Genus* 91. *Geometra vernaria;* note.)

9. Gnop.

Species.	Icon.
9. Gnop. *Sartata*, Treitsch.*	— — —
10.—*Glaucinata*, Treitsch.	Hübn. Geom. tab. 28. f. 150. (mas.)
11.—*Pullata*, Wien. Verz....	Hübn. Geom. tab. 27. f. 145. (mas.)
12.—*Punctulata*, Wien. Ver.†	Hübn. Geom. tab. 61. f. 317. (fœm.)
13.—*Mucidata*, Treitsch....	Hübn. Geom. tab. 28. f. 148. (fœm.)
14.—*Carbonaria*, Linn......	Hübn. Geom. tab. 28. f. 151. (mas.)

Genus 95. BOARMIA, *Ochs.*, *Treitsch.*

(Boarmia, Duponchel.
Cleora, Alcis, Boarmia, Curtis, Stephens.)

Wings broad, dusky, with transverse, indented lines, and a dark spot near the centre of the disc; posterior margin with a dark, interrupted transverse line, or row of spots.—*Body* proportionally small and slender.—*Larva* cylindrical; *head* nearly concealed by the first segment of the body.—*Metamorphosis* subterranean.

Species.	Icon.
1. Boa. *Cinctaria*, Hübn.‡...	Hübn. Geom. tab. 31. f. 166. (fœm.) Curtis, Brit. Ent. ii. pl. 88.
2.—*Crepuscularia*, Hübn.§	Hübn. Geom. tab. 50. f. 158. (fœm.)
3.—*Selenaria*, Hübn.	Hübn. Geom. tab. 31. f. 163. (fœm.)

4. Boa.

* Gnop. alis cinereis nebulosis, striis obsoletis obscurioribus, margine externo maculis albis.—*Ochs. Treitsch.* vi. *pars* i. p. 175.

† Boarmia, Curtis.

‡ Cleora, Curtis, Stephens.—"*Antennæ* setaceous, long and slender.—*Maxillæ* slender, not so long as the antennæ.—*Labial palpi* projecting a little beyond the head, obtuse, thickly covered with scales, which extend considerably beyond the apex.—*Wings* undivided, slightly indented.—*Abdomen* robust, conical in the females.—*Legs* rather stout."—(Extract)—*Brit. Ent.* ii. pl. 88.

The genus Cleora was established some years since by Curtis, at which time he had never seen a male of the species he has so very beautifully figured in his 88th plate: but having lately received one, he finds that its antennæ are pectinated like those of the genus Alcis; whilst in Boarmia they are ciliated, or pilose beneath. In consequence of this recently acquired information, Curtis has removed the six species with which he originally supposed that Cleora *cinctaria* should be associated (on the probable, but, as it has proved, erroneous, assumption that the male insect would be found to have *ciliated, not pectinated,* antennæ) to the genus Boarmia. It does not distinctly appear whether Curtis proposes to abolish the Genus Cleora altogether, and transfer *cinctaria* to that of Alcis or not. Stephens however, at all events, retains it, including in it Treitschke's Geometra *bajularia*, and his Boarmia *lichenaria*, *viduaria*, *glabraria* (*lenearia*, Steph.) and *cinctaria*, and Thunberg's Geometra *pictaria*—(See Syst. Cat. part ii. p. 123.)

§ Boarmia, Curtis, Stephens.—"*Antennæ* inserted on the crown of the head, setaceous, clothed with scales above, composed of numerous joints, each

Species. Icon.

4. Boa. *Roboraria*, Fab.* † Hübn. Geom. tab. 32. f. 169. (mas.)
5.—*Consortaria*, Fab.† ...... Hübn. Geom. tab. 32. f. 168. (mas.)
6.—*Hortaria*, Fab. .... Hübn. Geom. tab. 29. f. 153. (mas.)
7.—*Abietaria*, Hübn.‡ § ... Hübn. Geom. tab. 30. f. 160. (mas.)
8.—*Lividaria*, Hübn. .... Hübn. Geom. tab. 26. f. 141. (mas.)
9.—*Repandaria*, Hübn.† ... Hübn. Geom. tab. 30. f. 161. (mas.)
10.—*Rhomboidaria*, Hübn.† Hübn. Geom. tab. 29. f. 154. (fœm.)
tab. 32. f. 170. (mas.)
11.—*Sociaria*, Hübn .... Hübn. Geom. tab. 29. f. 155. (mas.)
tab. 82. f. 424. (fœm.)
12.—*Extersaria*, Hübn.‖ ... Hübn. Geom. tab. 30. f. 159. (fœm.)
13.—*Secundaria*, Hübn ...... Hübn. Geom. tab. 29. f. 156. (mas.)
14.—*Lichenaria*, Fab.¶ ...... Hübn. Geom. tab. 31. f. 164. (mas.)
15.—*Viduaria*, Hübn.¶ ..... Hübn. Geom. tab. 31. f. 165. (mas.)
tab. 70. f. 364. (fœm.)
16.—*Glabraria*, Hübn.¶. ... Hübn. Geom. tab. 31. f. 162. (fœm.)
tab. 65. f. 339. (mas.)
17.—*Cineraria*, Fab .... Hübn. Geom. tab. 32. f. 171. (mas.)

[To be continued.]

each producing a series of long curved hairs in the males; simple in the females.—*Maxillæ* not so long as the antennæ.—*Labial palpi* short, porrected horizontally, thickly clothed with short scales.—*Head* small.—*Thorax* not large.—*Abdomen* rather long, slender and attenuated in the males, shorter, subconical or acuminated in the females.—*Upper wings* trigonate, lower with the margin deeply indented."—*Brit. Ent.* vi. pl. 280, in which Curtis has given a lovely figure of the female B. *tetragonaria*,—a species not known to Treitschke. In his enumeration of the British species of Boarmia, Curtis remarks that B. *abietaria*, (Geometra *abietaria*, *Haw.* 276. 14.) is not the *G. abietaria* of Hübner, "which is not only differently marked, but has the antennæ strongly pectinated, and is probably my *Alcis australaria*."—Haworth (*l. c. supra*,) refers to Hübner's G. *abietaria*, as identical with his own species, though with a mark of doubt; but Stephens (Syst. Cat. part ii. p. 125) gives the *abietaria* of Hübner, Treitschke, Haworth and Curtis, as identical, without any mark of doubt at all.

* Boarmia, Duponchel.

† Alcis, Curtis, Stephens.—"*Antennæ* inserted between the eyes, filiform, bipectinated in the males, simple towards the apex; branches ciliated, arising near the centre of the joint: simple, hairy beneath, with a bristle arising from each joint in the females.—*Labrum* and *mandibles* larger than usual.—*Maxillæ* long, slender, furnished with distinct tentacula towards the apex.—*Labial palpi* porrected, visible viewed from above, not hairy, thickly covered with broad scales, very much lengthened beneath, terminal joint not quite concealed.—*Wings* ample, extended horizontally, *superior* trigonate, *inferior* slightly indented.—*Abdomen* long, linear, somewhat truncated in the males, shorter and conical in the females.—*Legs* rather long and slender."—*Curtis, Brit. Ent.* iii. pl. 113, giving an excellent figure of *A. sericearia*, Curtis,—a species not mentioned by Treitschke.

‡ Alcis *australaria*, Curtis? § A. *abietaria*, Haw., Steph.

‖ Boarmia, Curtis, Stephens. ¶ Cleora, Stephens.

LIII. *On*

LIII. *On the Calculations requisite for predicting Occultations of Stars by the Moon. By Professor* Bessel*.

1.—EVERY observer of occultations must be aware how desirable or even necessary it is to know approximately the times of disappearance and reappearance of a star, as also the place on the moon's disk where the latter takes place; in order that the attention may not be weakened by being too long on the stretch, or diverted by the uncertainty of the place. To me, at least, it has always been necessary to calculate beforehand the occultation which I intended to observe, for my place of observation. I do not find anywhere an explanation of the most convenient method of conducting this calculation; although Lagrange's paper in the Berlin Ephemeris for 1782 contains its essential points, which have since been adopted in various works.

The columns of Æ. and Decl. of the moon for every twelve hours of apparent time, which are to be found in the *Conn. des Tems*, as well as in the Nautical Almanac, greatly facilitate this calculation; but it is still more simplified by the same data, for every mean noon and midnight, which are given in the excellent Ephemeris of Encke, with the accuracy of the tables themselves.

I shall first solve the problem with strict exactness, and next point out such an approximation as will be sufficient for the purpose of making the observation; and, lastly, I shall show what data the Ephemeris ought to contain, in order that the same quantities for other places may be deduced from the results of the calculations thus instituted for one place.

2. The symbols which I shall employ are as follow:

A apparent Æ.
D ——— Decl. } of the occulted star.

...... true Æ. ....
...... —— Decl. ....
...... equatorial parallax
...... horizontal semidiameter ..... } of the moon.
α' ...... apparent Æ. ....
δ' ...... ——— Decl. ....
ϱ' ...... apparent semidiameter ......

μ ...... sidereal time ....
ϕ ...... latitude ....
φ' ...... corrected latitude ....
r ...... distance from the centre of the earth } of the place of observation.

If we now draw a great circle through the star and the centre

* From Schumacher's *Astr. Nachr.* vol. vii. p. 1; also in Encke's *Ephemeris* for 1831, p. 257.

tre of the moon, and denote the distance of both measured on it by Σ, and the angle formed by this circle and the circle of declination passing through the star to the north pole by P, which is to be counted from 0° to 360°, so that P is between 0° and 180°, when $\alpha' < A$, and between 180° and 360°, when $\alpha' > A$, we shall have

$$(1)\begin{cases}\sin\Sigma\sin P = -\cos\delta'\sin(\alpha'-A)\\ \sin\Sigma\cos P = \sin\delta'\cos D - \cos\delta'\sin D\cos(\alpha'-A)\\ \cos\Sigma = \sin\delta'\sin D + \cos\delta'\cos D\cos(\alpha'-A)\end{cases}$$

The apparent place of the moon is expressed by the true one by means of these formulæ:

$$\begin{aligned}\Delta\cos\delta'\sin\alpha' &= \cos\delta\sin\alpha - r\cos\phi'\sin\pi\sin\mu\\ \Delta\cos\delta'\cos\alpha' &= \cos\delta\cos\alpha - r\cos\phi'\sin\pi\cos\mu\\ \Delta\sin\delta' &= \sin\delta - r\sin\phi'\sin\pi\end{aligned}$$

Δ being the distance of the moon from the place of observation. If we substitute these quantities in (1), we obtain

$$(2)\begin{cases}\Delta\sin\Sigma\sin P = -\cos\delta\sin(\alpha-A) + r\cos\phi'\sin\pi\sin(\mu-A)\\ \Delta\sin\Sigma\cos P = \sin\delta\cos D - \cos\delta\sin D\cos(\alpha-A)\\ \qquad - r\sin\pi\,[\sin\phi'\cos D - \cos\phi'\sin D\cos(\mu-A)]\\ \Delta\cos\Sigma = \sin\delta\sin D + \cos\delta\cos D\cos(\alpha-A)\\ \qquad - r\sin\pi\,[\sin\phi'\sin D + \cos\phi'\cos D\cos(\mu-A)]\end{cases}$$

which are the formulæ given by Lagrange, but referred to the equator.

3. For the beginning and the end of an occultation, we have $\Sigma = \varrho'$

and as $\Delta\ \sin\varrho' = \sin\varrho$,

we have likewise $\Delta\ \sin\Sigma = \sin\varrho$; by which the apparent radius of the moon disappears from the first two of the formulæ (2), if applied for calculating the occultation or emersion. We have, therefore, for these cases

$$(3)\begin{cases}\sin\varrho\sin P = -\cos\delta\sin(\alpha-A) + r\cos\phi'\sin\pi\sin(\mu-A)\\ \sin\varrho\cos P = \sin\delta\cos D - \cos\delta\sin D\cos(\alpha-A)\\ \qquad - r\sin\pi\,[\sin\phi'\cos D - \cos\phi'\sin D\cos(\mu-A)]\end{cases}$$

and the third formula is of no further use, as it only decides whether the distance is ϱ' or $180°-\varrho'$, which is never doubtful.

If we divide these formulæ by $\sin\pi$ and assume $\sin\varrho = k\sin\pi$, where the constant quantity k is according to Burckhardt's Tables $=0{\cdot}2725$, and its logarithm $= 9{\cdot}4353665$, they will be changed into the following ones:

$$(4)\begin{cases}k\sin P = \dfrac{\cos\delta\sin(\alpha-A)}{\sin\pi} + r\cos\phi'\sin(\mu-A)\\[2ex] k\cos P = \dfrac{\sin\delta\cos D - \cos\delta\sin D\cos(\alpha-A)}{}\\ \qquad - r\,[\sin\phi'\cos D - \cos\phi'\sin D\cos(\mu-A)]\end{cases}$$

 which

which consist of two separate parts; one of which depends only on the place of the moon, while the other depends on the place of observation only. The sum of the squares of both gives this equation:

$$(5)\ldots k^2 = \left\{ \frac{\cos\delta \sin(\alpha - A)}{\sin\varpi} - r\cos\varphi' \sin(\mu - A) \right\}^2$$
$$+ \left\{ \frac{\sin\delta\cos D - \cos\delta\sin D\cos(\alpha - A)}{\sin\varpi} - r[\sin\varphi'\cos D - \cos\varphi'\sin D\cos(\mu - A)] \right\}^2$$

As the parts which are to be squared may be considered as functions of the time, these formulæ contain no other unknown quantity but the time of occultation or emersion.

4. The times of innumerable occultations and emersions will be contained in this equation if taken without restriction, and it is consequently a transcendental one and cannot be solved by a direct process; it is only to be solved by trials or by successive approximations. The latter proceeding appears to me to be more convenient. I assume, therefore, α, δ, π, μ as known for a time T, which is so near to the time of occultation or emersion T + t which is required, that the terms on the right of the sign of equality may be converted into rapidly converging series. On this supposition we assume

$$\frac{\cos\delta\sin(\alpha - A)}{\sin\varpi} \ldots\ldots\ldots\ldots = p + p' t$$
$$\sin\delta\cos D - \cos\delta\sin D\cos(\alpha - A)\ldots\ldots = q + q' t$$
$$r\cos\varphi'\sin(\mu - A)\ldots\ldots\ldots\ldots\ldots\ldots = u + u' t$$
$$r\sin\varphi'\cos D - r\cos\varphi'\sin D\cos(\mu - A) = v + v' t,$$

and p, q, u, v are the values corresponding to the time T; while p', q', u', v' are functions of t, in which, however, agreeably to our supposition, the terms dependent on t and its higher powers are very small. If we suppose that t is approximately known as far as it has influence on the value of these quantities, the solution of equation (5), or what it will be after making the above subtitutions, viz.

$$(6)\ldots k^2 = [p - u + (p' - u')\,t]^2 + [q - v + (q' - v')\,t]^2$$

will produce a greater approximation for t; by means of which values for $p' - u'$ and $q' - v'$, more accurate than those assumed in the calculation, will be obtained, which substituted in the formula will again lead to a closer approximation to the value of t, and so on.

The solution of equation (6) will be facilitated by making

$$p - u = m\sin M, \qquad p' - u' = n\sin N$$
$$q - v = m\cos M, \qquad q' - v' = n\cos N;$$

by

by the substitution of these values it becomes

$$k^2 = m^2 \sin(M-N)^2 + [m \cos(M-N) + n\,t]^2$$

and if we suppose

$$\frac{m}{k} \sin(M-N) = \cos\psi, \quad \text{we have}$$

$$(7) \ldots\ldots t = -\frac{m}{n} \cos(M-N) \mp \frac{k}{n} \sin\psi$$

where the upper sign is to be used for an occultation, and the lower one for an emersion, provided ψ has been taken below $< 180°$, which may always be done. If we find, however, $\frac{m}{k} \sin(M-N) > 1$, there will be no occultation, but the moon will pass by the star without occultation. It is evident, however, that this is only necessarily the case after the approximation has been pushed far enough, and that an error in N may produce the appearance of the impossibility of an occultation which really will take place, and *vice versâ*. If cos ψ be found > 1, t is, notwithstanding, to be calculated by the formula

$$t = -\frac{m}{n} \cos(M-N)$$

and with this value the approximation is to be continued; it will then appear whether cos ψ is really greater than 1. In like manner a ψ, which a rough approximation would show to be possible, might prove impossible by a greater approximation. These cases, however, if T is not too distant from the time of occultation, will only occur when the star remains very near the limb of the moon.

The formula (4) will be converted into the following one, by introducing the symbols adopted in this section,

$$\begin{aligned} k \sin P &= -m \sin M - n \sin N \,.\, t \\ k \cos P &= m \cos M + n \cos N \,.\, t \end{aligned}$$

and hence by substituting the value of t we obtain these:

$$\begin{aligned} k \sin P &= -m \sin(M-N) \cos N \pm k \sin N \sin\psi \\ k \cos P &= -m \sin(M-N) \sin N \mp k \cos N \sin\psi \end{aligned}$$

and, as $m \sin(M-N) = k \cos\psi$, we have

$$\sin P = -\cos(N \pm \psi); \quad \cos P = -\sin(N \pm \psi)$$

and

$$(8) \ldots\ldots P = 270° - N \mp \psi$$

If we choose to describe the place of occultation or emersion by the angle which is inclosed by the great circles drawn from the moon's centre through the star and the north pole, beginning from the north and counting to the left, we shall very nearly have this angle $Q = 180° - P = N \pm \psi - 90°$.

5. The quantities p, q, p', q' which depend on the motion

of the moon, may be most conveniently found by calculating the values of

$$\cos\delta \sin(\alpha - A) \quad \text{and} \quad \frac{\sin\delta \cos D - \cos\delta \sin D \cos(\alpha - A)}{\sin\pi}$$

or different times, for which purpose the latter may be thus expressed:
$$\frac{\sin(\delta - D)\cos\tfrac{1}{2}(\alpha - A)^2 + \sin(\delta + D)\sin\tfrac{1}{2}(\alpha - A)^2}{\sin\pi}$$

It will be most convenient to assume for T the full hour of the place for which the Ephemeris has been calculated, nearest to the middle of the occultation, and for the other times the full hours next preceding and following it: by this arrangement it will be possible to perform the interpolation from the Ephemeris with coefficients, which once calculated will serve for ever. In order to place together every thing requisite for this calculation, I shall here communicate a table for these coefficients, which will be illustrated by the following arrangement of the quantities to which they refer.

Times.	Places.	1 Diff.	2 Diff.	3 Diff.	4 Diff.	
$\tau_{\prime}$	$a_{\prime}$		$c_{\prime}$		$e_{\prime}$	
		b		d		.....
τ'	a'		c'		e'	

where $a_{\prime}\, a'$ denote the places of the moon contained in the Ephemeris corresponding to the beginning $\tau_{\prime}$ and the end τ' of the 12 hours in which the times T, $T \mp 1^h$, $T \mp 2^h$, ... are contained, and b, c, d, &c. the successive differences. If we assume $a_{\prime} + a' = 2a$; $c_{\prime} + c' = 2c$; $c_{\prime} + c' = 2c$; .. we have the place of the moon corresponding to the time

$$\tfrac{1}{2}(\tau_{\prime} + \tau') + x$$

by this formula

$$a + X.b + X'.c + X''.d + \&c....$$

in which the coefficients have the following values:

x.	12 X	288 X'	10368 X''	497664 X'''	log X	log X'	log X''	log X'''
-8^h	−8	+28	−224	− 7280	9·82391n	8·98777	8·33455n	8·16520n
−7	−7	+13	− 91	− 3575	9·76592n	8·65455	7·94336n	7·85634n
−6	−6	0	0	0	9·69897n	−∞	−∞	−∞
−5	−5	−11	+ 55	+ 3289	9·61979n	8·58200n	7·72467	7·82013
−4	−4	−20	+ 80	+ 6160	9·52288n	8·84164n	7·88740	8·09264
−3	−3	−27	+ 81	+ 8505	9·39794n	8·97197n	7·89279	8·23274
−2	−2	−32	+ 64	+10240	9·22185n	9·04576n	7·79048	8·31336
−1	−1	−35	+ 35	+11305	8·92082n	9·08468n	7·52837	8·35633
0	0	−36	0	+11664	−∞	9·09691n	−∞	8·36991
+1	+1	−35	− 35	+11305	8·92082	9·08468n	7·52837n	8·35633
+2	+2	−32	− 64	+10240	9·22185	9·04576n	7·79048n	8·31336
+3	+3	−27	− 81	+ 8505	9·39794	8·97197n	7·89279n	8·23274
+4	+4	−20	− 80	+ 6160	9·52288	8·84164n	7·88740n	8·09264
+5	+5	−11	− 55	+ 3280	9·61979	8·58200n	7·72467n	7·82013
+6	+6	0	0	0	9·69897	−∞	−∞	−∞
+7	+7	+13	+ 91	− 3575	9·76592	8·65455	7·94336	7·85634n
+8	+8	+28	+ 224	− 7280	9·82391	8·98777	8·33455	8·16520n

6. For

6. For the example given by Professor Encke, viz. the occultation of 82 Leonis, 5th of April 1830, we have from the Ephemeris the right ascension of the moon on

April 4. 0^h	153°41′ 31″·8				
		5°50′ 21″·1			
12	159 31 52 ·9		−4′ 25″·3		
		5 45 55 ·8		+55″·5	
5. 0	165 17 48 ·7		−3 29 ·8		+1·7
		5 42 26 ·0		+57 ·2	
12	171 0 14 ·7		−2 32 ·6		−0·1
		5 39 53 ·4		+57 ·1	
6. 0	176 40 8		−1 35 ·5		
		5 38 17 ·9			
12	182 18 26 ·0				

hence

$$
\begin{aligned}
a &= 168° \; 9' \; 1''{\cdot}7 \\
b &= +5 \; 42 \; 26 \cdot 0 \\
c &= -3 \; 1 \cdot 2 \\
d &= +57 \cdot 2 \\
e &= +0 \cdot 8
\end{aligned}
$$

In the same manner we have for the declination

$$
\begin{aligned}
a &= +4° 52' 45''{\cdot}55 \\
b &= -1 \; 48 \; 44 \cdot 7 \\
c &= -2 \; 33 \cdot 25 \\
d &= +1 \; 1 \cdot 7 \\
e &= -1 \cdot 0
\end{aligned}
$$

and for parallax

$$
\begin{aligned}
a &= 54' \; 12''{\cdot}2 \\
b &= -7 \cdot 0 \\
c &= +1 \cdot 8
\end{aligned}
$$

Hence we derive for 5^h, 6^h, 7^h, 8^h, 9^h mean time of Berlin

	α	δ	π
5^h	167°40′ 51″·76	+5° 2′ 8″·09	54′ 13″·00
6	168 9 24 ·37	4 53 4 ·69	12 ·43
7	168 37 55 ·72	4 44 0 ·22	11 ·84
8	169 6 25 ·83	4 34 54 ·73	11 ·23
9	169 34 54 ·75	4 25 48 ·24	10 ·62

If we assume, agreeably to Encke, for the position of the star $A = 169° \; 14' \; 6''{\cdot}6$; $D = + 4° \; 14' \; 4''{\cdot}8$,

we obtain the following values of $\frac{\cos\delta \sin(\alpha - A)}{\sin \pi}$

5^h	−1·71312			
		+52384		
6	−1·18928		+12	
		+52396		−2
7	−0·66532		+10	
		+52406		−6
8	−0·14126		+ 4	
		+52410		
9	−0·38284			

and these values of $\sin(\delta - D) . \cos\frac{1}{2}(\alpha - A)^2 + \sin(\delta + D) . \sin\frac{1}{2}(\alpha - A)^2$

5^h

5h	+0·88807			
		−16778		
6	+0·72029		−11	
		−16789		+7
7	+0·55240		− 4	
		−16793		0
8	+0·38447		− 4	
		−16797		
9	+0·21650			

If we have calculated for an odd hour in which the term T is contained, the formula for the interpolation of the column a is

$$a + t\,.\,b + \frac{t^2}{2}\,.\,c + \frac{t\,.\,(t^2-1)}{2\,.\,3}\,d + \&c. =$$

$$a + t\left\{b - \frac{1}{6}\,d + \qquad .\,c + \frac{t^2}{6}\,d.\qquad\right\}$$

whence we obtain for our example

$$p = -\ 0{\cdot}66532$$
$$p' = +\ 0{\cdot}524017 + t\,.\,0{\cdot}00005 - t^3\,.\,0{\cdot}000007$$
$$q = +\ 0{\cdot}55240$$
$$q' = -\ 0{\cdot}167904 - t\,.\,0{\cdot}00002 + t^2\,.\,0{\cdot}000006$$

But I do not believe that one can ever have an object in going beyond the second differences, or in making the calculation for more than three hours: if the accuracy were to be pushed to a greater degree, it would likewise be necessary to apply a greater number of decimals than is here done.

[To be continued.]

LIV. *On the Mutual Action of Sulphuric Acid and Alcohol, and on the Nature of the Process by which Æther is formed.* By HENRY HENNELL, *Esq.* *Communicated by* WILLIAM THOMAS BRANDE, *Esq. F.R.S.**

1. I WAS some time since engaged in an investigation of the nature of oil of wine and of the salts called sulphovinates: the results I obtained were considered of sufficient importance to be honoured with a place in the Philosophical Transactions†. The oil of wine and sulphovinic acid are substances produced during the mutual action of sulphuric acid and alcohol in the well-known process adopted for the preparation of æther; and an important point with me, during the above investigations and since that time, has been to develop the particular changes which take place when æther is formed from sulphuric acid and alcohol. I perceive by the *Annales de Chimie* for November last, that MM. Dumas and Boullay have been engaged on the same subject, and have experimented on and considered, not only the formation of æther,

* From the Philosophical Transactions for 1828. Part I.
† Phil. Trans. 1826. Part III.

but

but also the nature of sulphovinates, and, as they supposed, though incorrectly, of oil of wine*. That our results with regard to sulphovinates and oil of wine differ, may be seen from the published accounts; and there is not less difference between their conclusions with regard to ætherification, and the results I have obtained, which I have now to describe.

2. When alcohol and sulphuric acid in equal weights are put together without the application of any heat beyond that generated during the mixture, the most abundant and important product is sulphovinic acid, above one half of the sulphuric acid being converted into that peculiar acid by union with hydro-carbon †. But when such a mixture containing so large a proportion of sulphovinic acid is distilled, the most important product is a new substance, namely æther, and the sulphovinic acid disappears. The questions which then arose were, whether the æther was formed altogether from the direct action of the remaining alcohol and sulphuric acid in the mixture, or whether the sulphovinic acid might not also assist, or whether it might not be an essential state of the elements intermediate between the mixture of the acid and alcohol and the development of the perfectly formed æther. MM. Dumas and Boullay, who have considered the same questions, or at least some of them,—decide, that the portions of materials which form æther, are altogether independent of those which produce sulphovinic acid: but the following facts prove in my opinion the contrary of this conclusion.

3. A portion of oil of vitriol was selected for some comparative experiments, and also some alcohol of specific gravity 0·820: five hundred grains of the oil of vitriol precipitated by acetate of lead, gave 1500 grains of sulphate of lead.

4. Five hundred grains of the oil of vitriol were mixed with five hundred grains of the alcohol, and after forty-eight hours, diluted and precipitated by acetate of lead; only 616 grains of sulphate of lead were produced; so that very nearly three-fifths of the sulphuric acid had become sulphovinic acid by the effect of mixture, and little more than two-fifths remained to act as sulphuric acid upon the remaining alcohol, full two-thirds of the quantity employed.

5. Another mixture of acid and alcohol in the same proportions, and made at the same time as the above, was then di-

* The substance which these gentlemen operated upon appears, from their own account of its preparation, to have been the hydro-carbon separable from oil of wine by the action of alkalies, and not that peculiar substance which has hitherto been called oil of wine.

† The sulphuric acid loses half its saturating power by the union, and all the salts formed by the new acid are soluble.

stilled

stilled until 117 grains had passed over, consisting of water, alcohol, and a portion of æther. The residue in the retort had not undergone any charring effect; and being diluted, was precipitated by the acetate of lead: the quantity of sulphate of lead obtained, amounted to 804 grains, indicating an increase in the quantity of sulphuric acid equivalent to 188 grains of sulphate of lead.

6. A similar mixture of alcohol and sulphuric acid, made at the time and in the same proportions as the two former, was then distilled until two hundred grains had been received, the greater part of which was æther; the uncharred residual matter in the retort being then diluted, was precipitated by acetate of lead as before; 986 grains of sulphate of lead were obtained. This contained nearly two-thirds of the sulphuric acid first added, and the increase by distillation had been much more than one-half of that which existed before the application of heat: so that during the distillation, and simultaneously with the formation of æther, a quantity of sulphovinic acid had been re-converted into sulphuric acid, and the latter appeared to increase in quantity in proportion to the increase of æther in the distilled products.

7. A similar mixture of alcohol and acid, made at the same time and in the same proportions as the three former, was then distilled until two hundred grains had passed over. Two hundred grains of water were added to the contents of the retort; 160 grains were distilled off; a second addition of two hundred grains of water was made, and the distillation continued: a further addition of five hundred grains of water was made, and the operation continued until as much product had been separated as equalled the water added;—the object was to separate all the æther and alcohol possible, for the purpose of ascertaining to what extent the conversion of sulphovinic acid into sulphuric could be carried. No smell of sulphurous acid was produced during the operation, nor did any charring of the contents of the retort occur; when precipitated by acetate of lead, 1480 grains of sulphate of lead were obtained. This is very little short of the 1500 given by the acid when unacted upon by alcohol, and shows that nearly the whole of the sulphovinic acid had been changed back into the state of sulphuric acid; and is completely at variance with the opinion, that when sulphuric acid and alcohol act upon each other, hypo-sulphuric acid is formed.

8. From these experiments it appeared probable that the æther was the product of the decomposition of the sulphovinic acid: but a mixture of equal weights of alcohol and sulphuric acid contains, besides the sulphovinic acid, a considerable

quantity

quantity of unaltered acid and alcohol; for in such a mixture three-fifths (4) of the sulphuric acid would be converted into sulphovinic acid by combination with the hydro-carbon of less than one-third of the alcohol employed. I next proceeded to ascertain, whether, when no alcohol was present, æther would be produced. A quantity of the sulphovinate of potash was therefore prepared. The composition of this salt has been given in the paper in the Philosophical Transactions before referred to, and one hundred parts contain 28·84 of potash. Five hundred grains were mixed with 150 grains of sulphuric acid, being nearly the equivalent of the potash in the salt, and then heat applied. The experiment therefore may be considered as the distillation of sulphovinic acid mixed with sulphate of potash, which it may be presumed remained inert during the process, and also with the water of the acid and of the salt. The proportion of water, it is found, has an important influence; but in the present experiment about a drachm of fluid distilled over, and left a blackened and acid salt in the retort, having the smell of sulphurous acid. A few grains of carbonate of potash being added to the distilled product, abstracted a little water: the clear decanted liquor was then mixed with a little dry muriate of lime, and by agitation separated into two portions; the upper one being decanted, amounted to nearly half a drachm, and was found to be pure æther. This result proves that æther may be formed from a sulphovinate or sulphovinic acid when no alcohol is present.

9. An experiment similar to the last in the nature and proportions of the substances used, was made, except that the sulphovinate was dissolved in its own weight of water previous to the addition of the sulphuric acid. The experiment is one therefore of the distillation of dilute sulphovinous acid, in place of that which is concentrated. The distilled product had no smell of æther, nor could any be discovered in it. About nine fluid drachms were obtained; to these, carbonate of potash was added, which separated the water, and left three drachms of a supernatant liquid, appearing by taste, smell and flame, to be alcohol: this was decanted, and poured upon muriate of lime; no æther separated, but the whole formed one solution; being distilled from the muriate it was evidently alcohol; and being mixed with its weight of sulphuric acid, gave sulphuric æther or sulphovinic acid again.

In this experiment there was no charring of the contents of the retort; and by precipitation by acetate of lead, the whole of the sulphuric acid was obtained;—not only the portion added to decompose the salt, but the double portion evolved

from the sulphovinic acid upon the separation and re-arrangement of the hydrocarbon.

10. In the former paper it was shown that oil of wine when heated in water is resolved into hydrocarbon and sulphovinic acid: an experiment was therefore made upon it. Two hundred grains of oil of wine were placed in a retort, a little water added, and heat applied: about a drachm was received, which being redistilled from carbonate of potash the product appeared to be principally alcohol, but the presence of æther was very evident.—This experiment proves the formation of æther from sulphovinic acid when no sulphuric acid was present as such at the commencement of the distillation.

With regard to the questions at the commencement of this paper, it appears to me from the facts detailed, that in the usual process for obtaining æther, the æther is not formed altogether from the direct action of the alcohol and sulphuric acid considered independently of the sulphovinic acid present; for the quantity of free sulphuric acid is small compared to the quantity of alcohol present, two-fifths only of the acid remaining, while of the alcohol more than two-thirds remain; and further, sulphovinic acid alone is readily converted into æther and sulphuric acid, (see 8.) and during the distillation of æther in the ordinary way the sulphovinic acid is always re-converted more or less completely into sulphuric acid (4. 5. 6.) it probably therefore assists much in the process. With regard to the third question, the opinion may be supported that the formation of sulphovinic acid is a necessary and intermediate step to the production of æther from alcohol and sulphuric acid; and although I do not mean to assert this view, yet it deserves a few remarks.

In no manner which has yet been devised can æther be formed from alcohol and sulphuric acid without the presence of sulphovinic acid. Whenever æther has been formed, sulphovinic acid has been present; whenever the sulphuric acid is diluted so far as not to form sulphovinic acid with alcohol, it also refuses to form æther with alcohol. Sulphovinic acid will produce æther without the assistance of alcohol. And although the æther produced when a mixture of equal weights of alcohol and sulphuric acid are distilled, appears to be in greater quantity than can arise from the decomposition of the sulphovinic acid existing in the mixture previous to the action of heat, it is not I think inconsistent to suppose, that at the same time that one portion of sulphovinic acid is resolved into sulphuric acid and æther, another may be formed from alcohol and sulphuric acid; and that sulphovinic acid is formed in a mixture

mixture of sulphuric acid and alcohol by heat, is proved by the following experiment. Five hundred grains of oil of vitriol were diluted by five hundred grains of water; when cold, to the dilute acid was added two thousand grains of alcohol, specific gravity 0·820. The following day this mixture was examined for sulphovinic acid, but none had been formed: it was placed in a retort, and a quantity distilled off nearly equal to the weight of the alcohol employed: this had a specific gravity of 0·842. Carbonate of potash separated a considerable portion of water, the original alcohol would not even moisten that salt; the residue in the retort was examined, and now sulphovinic acid was found; the evidence of which was, carbonate of lead being dissolved in considerable quantity; here sulphovinic acid had been formed by heat, where it did not previously exist. This result appears also opposed to the opinion, that in the formation of æther the sulphuric acid acts simply by abstracting water from the alcohol; for the dilute acid here gave up a portion of its water during the distillation, and separated from the alcohol a portion of hydrocarbon.

It has already been shown (9.) that the production of æther is materially influenced by the quantity of water present, and that the same sulphovinic acid will yield either æther or alcohol, as it is in a concentrated or dilute state. The hydrocarbon which, as was shown in the former paper, has the extraordinary power in oil of wine of neutralizing the whole of the acid properties of sulphuric acid, and in sulphovinic acid of neutralizing the half of them, being in the latter body in so peculiar a condition that it will unite either with that proportion of water necessary to form æther, or with the larger proportion requisite to form alcohol, according to circumstances.

In the experiments (8. 9.), in the production by distillation of æther or alcohol from sulphovinic acid more or less diluted, it appeared that sulphovinic acid might easily have its proximate elements separated and restored to their original state of sulphuric acid and alcohol. The following experiment was made with a view to illustrate this point. Five hundred grains of acid and five hundred grains of alcohol were mixed as before, and left for several days: by previous experiment it is known that more than half the sulphuric acid in this way becomes sulphovinic acid (4). By distillation and dilution at proper periods this would have given æther and alcohol, and nearly the whole of the sulphuric acid (7.): but instead of doing this, it was mixed with one thousand grains of water, and then distilled until 1400 grains had passed over. No charring or decomposition of the sulphuric acid took place; no

 æther

æther was formed; but nearly the whole of the original alcohol and sulphuric acid were recovered. It may be a question whether the production of alcohol and æther in those and similar experiments is altogether determined by the proportion of water present, or whether the difference of temperature consequent upon its variation may not have an effect.

When æther and sulphuric acid are heated together, oil of wine and sulphovinic acid are amongst the products obtained; and as this sulphovinic acid is readily converted when diluted into alcohol and sulphuric acid, so it affords a method of converting æther into alcohol: thus æther may be formed from alcohol, and alcohol from æther at pleasure, by throwing the hydrocarbon of these bodies into that peculiar state which it assumes when combined with sulphuric acid in sulphovinic acid. We may even proceed beyond this, and form either alcohol or æther, using olefiant gas as the hydro-carbon base: for I have shown in my last paper, that olefiant gas by combining with sulphuric acid, forms sulphovinic acid, and the acid so produced forms either æther or alcohol, according to circumstances which are under perfect command.

It can hardly be necessary to refer to the extraordinary remark at the end of MM. Dumas and Boullay's second paper, except to state that it is singularly at variance with the facts and opinions given throughout the former part of that and the preceding paper by the same authors. Those persons who read both papers, and also those of Mr. Faraday and myself, which were published long before the appearance of the former, will be able to decide without further comment from whom the particular views contained in those papers first emanated.

Apothecaries' Hall. H. Hennell.

LV. *On the right Use of Generic Names in Natural History; according to the Opinions of* MM. Cuvier *and* DeCandolle.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN the discussion, respecting the introduction and use of the generic names in Zoology, which has lately occupied some pages of your Magazine*, and which has been termed the breaking up the established genera of the older naturalists, especially of those of Linnæus; it appears to me that the parties to this controversy have entirely overlooked the purposes for which the new names were invented, and to which they were intended to be applied.

* Vol. iii. p. 213, and vol. vi. p. 199.

M. Cuvier,

M. Cuvier, the great inventor of this new nomenclature, and on whose authority I presume the use of it is supposed to be sanctioned, I believe never intended they should be applied in the manner now adopted. The extract which I annex from the Preface to the first edition of his *Règne Animal*, and which he has repeated in that lately published, seems to me conclusive on this point.

The names of the grand genera are alone on his authority to be used in speaking of the species, whilst those of the sub-genera or sections are to be applied solely in the exhibition of any systematic arrangement of the genera.

In making these observations, pray let it be understood that I am not advocating the preservation of any genus of animals, which evidently requires the separation of individuals united with it from want of sufficient knowledge of the species by the original framers of the genus. It is against the sub-division only of those genera which are acknowledged by naturalists to be perfect, but which have been formed into sections with particular objects in view by M. Cuvier and others.

As the specific names of all the individuals belonging to the sub-genera of any one grand genus in the higher orders of the animal kingdom are different, what but confusion can result from substituting as generic appellations the various sub-generic names instead of that of the grand genus which includes the whole?

M. DeCandolle's use and adoption of sub-genera in the vegetable kingdom seem entirely to accord with the rule laid down by M. Cuvier; for although he has in numerous instances given names to his sections, neither he nor his cotemporaries have ever attempted to designate the species by any of the inferior appellations: the grand generic names are invariably used. I am, Gentlemen, yours, &c.

London, Oct. 23, 1829. J. S.

Extract from the Preface to the First Edition of Cuvier's "Règne Animal."

"Il m'a fallu malheureusement introduire beaucoup de noms nouveaux, quoique j'aie mis une grande attention à conserver ceux de mes devanciers ; mais les nombreux sous-genres que j'ai etablis exigeaient ces denominations ; car dans des choses si variées, la memoire ne se contente pas d'indications numeriques. Je les ai choisies, soit de manière à indiquer quelque caractère, soit dans les denominations usuelles que j'ai latinisées, soit enfin, à l'exemple de Linnæus, parmi les noms de la mythologie, qui sont en general agréables à l'oreille, et que l'on est loin d'avoir epuisés.

"Je

"Je conseille neanmoins, quand on nommera les espèces, de n'employer que le substantif du grand genre, et le nom trivial. Les noms de sous-genres ne sont destinées qu'à soulager la mémoire, quand on voudra indiquer ces subdivisions en particulier. Autrement, comme les sous-genres, déjà très multipliés, se multiplieront beaucoup plus par la suite, à force d'avoir des substantifs à retenir continuellement, on sera exposé à perdre les avantages de cette nomenclature binaire, si heureusement imaginée par Linnæus.

"C'est pour la mieux consacrer, que j'ai demembré le moins qu'il m'a été possible les grands genres de cet illustre reformateur de la science. Toutes les fois que les sous-genres dans lesquels je les divise n'ont pas dû aller à des familles différentes, je les ai laissés ensemble sous leur ancien nom generique. C'etait non seulement un egard que je devais à la mémoire de Linnæus, mais c'etait aussi une attention nécessaire pour conserver la tradition et l'intelligence mutuelle des naturalistes des differents pays."

[The importance which must be attached to the opinion of M. Cuvier on the subject of our correspondent's letter, induces us to take the liberty of subjoining a translation of the passage quoted.—Ed.]

"I have unfortunately been obliged to introduce many new names, although I have made it a great object of attention to preserve those of my predecessors; but the numerous sub-genera which I have established required these denominations; for in things so varied, the memory is not satisfied with numerical indications. I have chosen them, either so as to indicate some character, or from the common appellations which I have Latinized, or lastly, according to the example of Linnæus, among the names of mythology, which are in general agreeable to the ear, and which are far from being exhausted.

"I nevertheless advise, when species are mentioned, that the substantive of the grand genus only should be made use of, and the trivial name. The names of sub-genera are only intended to relieve the memory, in those cases in which it is wished to indicate these subdivisions in particular. Otherwise, as the sub-genera, already very numerous, will become much more so in course of time,—in consequence of having substantives continually to remember,—we should be exposed to the loss of the advantages of that twofold nomenclature so happily contrived by Linnæus.

"It is in order the better to preserve it sacred, that I have dismembered in the least degree that I possibly could the great genera of that illustrious reformer of science. In all cases in

in which the sub-genera into which I divide them have not to be assigned to different families, I have left them together under their old generic name. This was not only a regard which I owed to the memory of Linnæus, but it was also an attention necessary for preserving the communication and mutual understanding of the naturalists of different countries."

LVI. *On the Cultivation of Botany in England.* *By Professor* SCHULTES, *of Landshut.*

[For the following narrative of a visit to our country by a learned German naturalist in 1824, containing the opinions which he was led to form of some of our Scientific Institutions and men of science, we are indebted to the 1st Number of a new and interesting work, The Botanical Miscellany of Professor Hooker. The narrative was published in the *Botanische Zeitung* for 1825, and is the substance of a letter, addressed from London by Dr. Schultes, a Professor of Landshut in Bohemia, to the celebrated naturalist Count Sternberg.

"We must not be supposed," observes Dr. Hooker, "to assent to all that our author has said, either in regard to the objects which he saw, or to the views which he has been led to entertain of different persons and their actions. The shortness of his stay in England, and the circumstance of his obtaining information only through the medium of a foreign language, may be justly offered as an excuse for some inaccuracies; while an useful warning may be derived from them, as to the caution with which we should, ourselves, in distant countries, form our judgements.

"In the present instance, the mistakes to which we allude are of so trifling a kind, and are so amusing, that we only wish our English travellers always erred in an equally charitable and cheerful manner."]

AFTER a passage of twenty-four hours across the Channel, we landed at Harwich on the 26th day of August. Here we had an immediate opportunity of experiencing the vexatious interpretation of a regulation which, under Napoleon's government, would have been cried out against by the English as an invention of military despotism; but which in this land of liberty, as it is called, has subsisted for these hundred years. This law lays a tax of several pence on every pound-weight of books imported into the kingdom. Now we had with us on board the packet half a dozen folios, for the purpose of drying within their pages the plants which we should collect on our journey; and although these were only old works on law and divinity, which

which were useless except as paper for specimens, we were required nevertheless to pay a tax amounting to thirty florins; and this merely because they were in the form of books. Much playful argument and some serious remonstrance were employed on this occasion; and we at length prevailed on the ignorant officer, who could not even read the titles of these works, to allow them to remain in his hands, (where they would probably be useless except to curl his old red wig withal,) by means of which arrangement we escaped the heavy impost, but were compelled to take our plants, one by one, out of these folios, and to purchase, at a high price, fresh paper in Ipswich; thus losing both time and money by the bad interpretation of a worse law. May this our unlucky experience serve as a warning for such botanists as shall hereafter travel in England, not to dry the plants which they may collect on their journey in old books with brass clasps.

We passed up the river Orwell with the tide, to the little dull town of Ipswich; admiring in our way the beautiful banks which skirted this stream, and which seemed to form one grand park. What particularly struck us here was the deep full verdure of the meadows, and the almost black green of the trees, shrubs and plants, which grew in the hedges. We have frequently heard censures passed, and even made them ourselves, on the intense colours of the figures of plants in the *Flora Londinensis*, and English Botany; but we now plainly perceived that our complaint was unfounded, the prevailing hue of the vegetation being even of a deeper tone than it is represented in those plates. Except *Ulex europæus*, *Genista anglica*, and a species of *Rubus*, (which, though called by all the botanists of this country *R. fruticosus*, is not the plant which bears that name on the continent, of which the corollas are always pale red,) we observed nothing in the Flora of the road-sides which struck us as being different from that of Germany.

On the 27th, about noon, we proceeded in the mail-coach from Ipswich to Norwich, where, by a fortunate circumstance, we accomplished the object of our journey thither. Sir James E. Smith, to whom we made this pilgrimage, had just returned home from the country, and was on the point of again visiting his friends when we called on him at his beautiful house. Our joy was great at finding this most respectable man so far recovered from the severe illness which had threatened his life, as to be again enabled to devote his leisure hours to the *amabilis scientia*. He was then employed in revising some printed sheets of the third edition of his Introduction to the Study of Botany. Sir J. E. Smith displayed to us the treasures of his collection, (in reality the only one of its kind,) with a courtesy and

and kindness which are peculiar to great and well-educated men; and which in this truly noble person are heightened by such charms of gentleness and affability, as cannot fail to attract to him most forcibly even such individuals as have but once enjoyed the privilege of his society. The books of Linnæus, with their margins full of notes in the handwriting of the immortal Swede; many valuable MSS. of his, not yet published; the Linnæan Herbarium, in the same order and even occupying the very cases which had contained it at Upsal, (little as the old-fashioned form of these cabinets corresponds with the elegant arrangement of Smith's museum); the collection of insects, shells and minerals, which had belonged to this second creator of Nature;—all these are arranged and preserved by Sir James with a scrupulous care which almost borders on a kind of religious veneration. The relics of Mohammed are not enshrined with more devotion in the Kaaba at Mecca, than are the collections of Linnæus in the house of Sir J. E. Smith at Norwich. Whilst we bless the Providence that has placed these treasures of the Northern Prophet in the hands of such a Caliph, from whom (as Sir James, alas! has no family) they will pass into the possession of some valued friend or person who knows how to appreciate and feel their high value, and who will respect them as national property,—we, of the continent, must ever lament that they have fallen to the lot of the "*toto disjunctos orbe Britannos;*" as it is, unhappily, impossible for every botanist to make a voyage to this island, here to compare his specimens with those of Linnæus: "*Non cuivis homini contingit adire Corinthum.*" And yet, long as a *tribunal botanicum* or a *synodus botanica* shall continue to be earnestly desired for that common good, which is as much the object of the botanist as of any other child of Adam, so long must we wish that the following plan, which is the only practicable remedy to the distant situation of Linnæus's collections, should be adopted.—We would propose that in every place where botany is pursued with energy, a kind of Filial or Branch Herbarium (if I may so call it) should be established; consisting of such plants only as have been accurately and faithfully compared with the original collections of Linnæus, Thunberg, Pallas, Vahl, Desfontaines, Ruiz and Pavon, Willdenow, Humboldt, &c. The excellent Sir J. E. Smith would willingly open his treasures, and allow every facility to those who held these views.

If there should arise any opulent botanist on the continent, or if any of the Governments there should institute a complete herbarium, possessing all the Linnæan species, (which it would not be difficult at the present day to gather together,) and if

such herbarium were by the proprietor allowed to be compared by an able botanist with that of Linnæus; we should then have in that country a *faithful copy* of the Linnæan Herbarium, which would enable us, in doubtful cases, to determine with precision what it was that the great Swedish naturalist had meant by any given species. Without such a comparison of the larger collections with each other; for example, that of Berlin with that of Paris, and one or other of these with the Banksian or Lambertian herbaria,—no degree of certainty can be expected; and from the increase of extensive private unverified collections, the science must labour under a heavy disadvantage in the consequent accumulation of synonyms. If Sieber had identified the plants gathered by him in Crete and Egypt with many of those previously collected by Sibthorpe and Desfontaines, much doubt would have been removed; and if the late travellers in Brazil, Prince Nieuwied, Auguste St. Hilaire, Martius, and Pohl, had compared their treasures before describing them, many useless synonyms would never have existed. To travel from one herbarium to another, and to carry about, in the memory only, the characteristics of doubtful species, may well be found an almost impracticable task; and the confusion to which such an attempt is apt to give rise may be seen exemplified in one of our latest large botanical works. To decide upon plants which we have not seen, and only know from an erroneous diagnosis or imperfect description, is like a blind man judging of colours: "*Il faut voir dit l'aveugle.*"

Besides the Linnæan herbarium, Sir J. E. Smith has a large collection of plants of his own formation, which is especially rich in the productions of New Holland and Nepaul. The worthy Professor Wallich at Calcutta, whose health has lately suffered from an Indian climate, has greatly contributed towards the latter. The Linnæan specimens, as well as Sir James's private herbarium, are very well preserved; and after the old plan, which is now seldom followed on the continent, they are fastened down on a folio sheet of paper, and washed over with a solution of corrosive sublimate. Sir James has also under his care the plants of Sibthorpe, to aid him in the publication of his *Flora Græca*, which is now nearly completed.

Among the papers of Linnæus, their present possessor found a number of copies of two pamphlets by this illustrious man, which do not appear to have been ever published. One of them bears the title of "*C. Linnæi Observationes in Regnum Lapidum,*" and contains a view of the mineral kingdom, so far as it was known at the time of its being printed: the other is

intitled

intitled "*Orbis eruditi Judicium de Caroli Linnæi, M.D. Scriptis.*" Both fill a complete sheet of letter-press. Sir James was so kind as to give a copy of each to my son and myself, with his own signature affixed. The latter of these pamphlets, *sine loco et anno*, like the first, appears to be a defence of this illustrious man extorted from him by some of his envious and prejudiced contemporaries. But what redounds as much to the honour as it must have done to the peace of the cautious and amiable Linnæus, is, that after having composed this paper, which consists entirely of the testimony which was borne to his character by the principal naturalists of his time,—such as Boerhaave, Burmann, Sloane, Dillenius, Jussieu, Haller, Gesner, Gleditsch, Breynius, &c. &c.—he afterwards entirely suppressed it; and thereby deprived his opponents of those fresh subjects of disputation, which are sure to arise on such occasions, and which only furnish ground for sincere pity for the contending parties. It would appear as if the motto which Linnæus had chosen for this paper,

"*Famam extollere factis*
Hoc virtutis opus,"

had animated him with this feeling even while composing it.

The case is however quite different when the possessor of the Linnæan herbarium, and of the other treasures left by the creator of the *amabilis scientia*, is called on to defend himself in a couple of pamphlets against a learned body, under the firm of Universitas Cantabrigiensis, and before the whole European public to advocate the laws and privileges of mankind, and consequently those especially of his own country, against the usurping ignorance and fanaticism of the learned head of one college, who in our German language would be termed the Pro-rector, and against the fawning sycophancy of some slothful member*. In such cases, we may well exclaim, as Smith has done in his defence, in the words of Milton,

"I hate when Vice can bolt her arguments,
And Virtue has no tongue to check her pride."

The whole history which Sir J. E. Smith here gives,—and which I shall relate somewhere else, as characteristic of the English Universities, the question being one which affects the botanical world and the public at large,—is briefly as follows:

* The titles of these two pamphlets, which are scarcely known in Germany, and in which Sir J. E. Smith defends the eternal laws of truth, are: "Considerations respecting Cambridge, more especially relating to the Botanical Professorship; by Sir J. E. Smith, M.D. F.R.S. President of the Linnæan Society:"—and "A Defence of the Church and the Universities against such injudicious Advocates as Professor Monk and the Quarterly Review; by Sir J. E. Smith," &c.

 The

The present Professor of Botany at Cambridge, Mr. Thomas Martyn, having been for many years prevented from lecturing by illness, confided his office of Professor, in so far as it was the foundation of Walker, to the most eminent botanist in England, the President of the Linnæan Society, Sir J. E. Smith. Most of the members of the University were well pleased with this choice, inasmuch as it advanced the celebrity of the high school at Cambridge. In compliance with the desire of Martyn, Smith sacrificed his leisure, went to Cambridge, and there proposed to renew the lectures on botany, which for many years had been discontinued. But the Pro-rector of this University, Mr. Monk, formally laid an interdict on the Knight and President of the Linnæan Society, Sir J. E. Smith, prohibiting him from ascending the rostrum, because he was,—a Dissenter!—that is, a Christian of a different persuasion from Mr. Monk. What would be said of a German University which for such a reason should exclude so distinguished an individual as Smith? Had Cambridge been now in the situation of France, groaning under the rod of such an obscure fanatic as the Bishop of Hermopolis; or had Sir James, in any of his publications or in any part of his conduct, shown the least trace of irreligion,—then the University would have been justified in this procedure: but not only have all the works of Smith testified their author to be, in the highest sense of the word, a religious character; but his whole life has been a series of the exercise of Christian virtue and elevated piety. Who would have believed that an University within the walls of which the immortal Erasmus Roterodamus once taught, and which had produced such a man as Milton, should ever, and even in the twentieth year of the nineteenth century, sink to such a depth of barbarity! (*bestialität!*) But "*omnia jam fient*" &c.; and we must not wonder that in this island, as well as on the continent, there should be instances of the existence of dull heads and infected hearts in Universities, when the direction of these institutions is entrusted to the learned corps of *frères ignorantins.*

The few hours which Sir James Smith's kindness induced him to devote to me, though he was ready prepared to set off on a journey to join his *Smithia*, (a lady of rare talents,) passed away like a moment of time; just as the sweetest periods of life seem to fleet upon the swiftest wings. I have rarely beheld a more noble countenance; one indicative of such candour, simplicity and kindness, united with so much clearness of intellect, as that of Sir J. E. Smith; and the expression of his features will never be obliterated from my memory.

Sir James obtained for my son and myself admittance to the noble

noble hospital at Norwich; after which we quitted this romantic and prettily situated city, and proceeded by way of Newmarket to Cambridge. The coach, like all those which carry the mail in England, went at too rapid a rate, and the day closed too early, to allow of our making many observations on the Flora of the somewhat barren country which lies between Norwich and Newmarket. We only noticed, from the road, some beautiful country seats, and a plantation of *Pinus sylvestris*, which, like the other tribes of fir, is a rarity on the plains of England, not being a native of this country.

We hired a postchaise from Newmarket to Cambridge, which is situated in a rather bleak neighbourhood. I shall describe the University in some other place, and only give a few words to the Botanic Garden, which, as far as such an establishment can be known by a Catalogue, is already known on the continent by the third edition which the deceased Donn and Pursh, together with Mr. Lindley, published in 1823. I had hoped here to meet my late friend Dr. E. D. Clarke, Professor of Mineralogy, who once spent an evening with me at Landshut, on his return from Egypt, and had invited me in return to see him and his garden at Cambridge. He knew not that he was asking me to come and see his effigy, when he gave me the invitation;—the marble bust which the University has placed to his honour in the library, is all that was left of my friend. I was told that Dr. Clarke's death was occasioned by the irritation that an insect gave rise to, and which was drawn into his nostril by smelling of a flower.

The garden at Cambridge contains about five acres of very bad ground, and there are from five to six thousand species of plants, the greater part of them cultivated in beds. It does not present so pleasing an appearance as the Dutch botanic gardens, but is, however, kept very neat, and is well arranged. The founder of this institution was the great Dr. R. Walker, Vice-master of Trinity College, who purchased the ground for 1600*l.* Bradley, the earliest botanist who paid exclusive attention to the succulent plants, was the first Professor of Botany at Cambridge, whom the celebrated Sherard recommended to the University. There were no lectures given here on botany till the year 1724; so that this eminent university is far behind many of those in Germany in this respect, which long before that period had supported botanical professors and gardens. Bradley ceased to give lectures six years before his death, when Sherard, and the great physician to the royal household Sloane, recommended John Martyn to the situation. Still, in the year 1734, Martyn discontinued his lectures, as there was no botanic garden, and he met with no support. "Botany slept," as

as Sir J. E. Smith says, "from 1734 till 1761, when R. Walker raised it from a deep slumber. The Professor of Botany had neither salary nor student." Walker provided both; and aided Martyn, who transferred his office to his son Thomas Martyn, then twenty-six years of age. The latter has been for the last three years prevented from lecturing by age and infirmity; and in 1818 he transferred his situation, (inasmuch as it related to Walker's foundation,) to Sir James E. Smith. But Monk, by interdict and proscription, prevented this worthy man from performing the duties of the Professorship; and the University of Cambridge appears to feel as little as it would have done a hundred years ago, that it has for the last six years been deprived of instruction in one of the most beautiful and useful of sciences. The care of the garden is committed to Mr. Biggs, whom we did not find at home. The stoves are well built, and they may have been hitherto large enough; but the progress of the science will soon cause their size to be insufficient, as they extend only to 216 feet. A building was erected some years ago, for the lecture-rooms of the Professors of Botany, Chemistry, Mineralogy, and Mechanics. The Alpine plants, among which are some rare species from the Scotch Highlands, are very properly cultivated in small pots, and placed during winter under glass. The assistant-gardener, who conducted me through the grounds, was not able to tell me the annual expenditure of the institution. The work-people receive two shillings a day.

The Library of the University contains many rare works; but little attention seems to be paid to Natural History: and even the collection of Minerals is not considerable, when compared with many of our mineral cabinets in Bavaria.

Our stay in London was extremely short; and we were anxious to take advantage of one of those clear days which are so uncommon in England, in order to visit Oxford, which is only about fifty-eight miles distant from the metropolis. We performed this distance in less than six hours, though at some risk of breaking our necks. Sir J. E. Smith had been so obliging as to give us a letter to his friend Dr. Williams, Professor of Botany and Librarian to the Radcliffe Library at the University of Oxford; and through the politeness of this highly estimable person we obtained a view of the treasures of natural history in Oxford, and also of the Radcliffe library and hospital.

The botanical garden at this University is the oldest in England, having been founded by Henry Lord d'Anvers Earl of Danby, in 1622, when the first stone was laid of a wall fourteen feet high which still exists, and which it took eleven years

to

to build, at an expense of 5000*l.* The erection of the gate by Neklaus Stone, for which Inigo Jones furnished the design, cost 500*l.* On either side of the entrance to the garden stands a statue; one of king Charles the First, and the other of his son Charles the Second: these were purchased with the amount of a fine, laid on the celebrated antiquarian Anthony à Wood, as a punishment for a satire which this good old man had ventured to publish in the first edition of the *Athenæ Oxonienses*, against the Earl of Clarendon. This garden had originally been the burial-place of the Jews, who lived in great numbers at Oxford, till the noted banishment and destruction of these state creditors in the reign of Edward the First, 1290. It was afterwards enlarged, and at present includes five acres. This addition of ground was however but a trifling improvement, and the danger of inundation to which it is exposed both in winter and summer still exists. The water frequently stands knee-deep above the plants; and as the lower parts of the garden cannot be sufficiently raised without an immense expense, these portions are left quite uncultivated. The active gardener, who is a Scotchman named Baxter, devotes his attention chiefly to the Cryptogamia; partly from mortification at finding it impossible to make the garden such as he could wish. He is preparing a *Flora Cryptogamica* of the environs of Oxford; and he showed us the first number of this work, containing specimens very neatly laid out, to which we must invite the attention of our countrymen in Germany. Mr. Baxter also cultivates with zeal the English Willows, having a living individual of almost every species, in a proper *Salicetum.* To the Grasses, likewise, he gives much attention; and, from the experience of several years, he is enabled to decide that *Agrostis verticillata*, *vulgaris*, *decumbens*, *fasciculata* (Curt.), and *stolonifera*, are distinct species; which, when subjected to the same culture for a great length of time, still continue to preserve their characteristic marks. This industrious man,—with the assistance of three persons, each of whom receives two shillings per day,—cultivates between four and five thousand species of plants in the wretched houses of this garden, though in fact there is only one stove, properly so called, and this is much too small. Those which grow in the open air are, like the plants of Cambridge, arranged agreeably to the Linnæan method, and separated into the indigenous and foreign kinds; and both of these are again divided into annual, biennial, and perennial, by which the study of the allied species becomes difficult. They are partly cultivated in beds, partly in separate squares; without any view to the effect which this must naturally offer to the eye.

Although

Although the Oxford garden is inadequate to the purposes of botanical instruction in the present state of science, and though the excellent Dr. Williams has been prevented from lecturing this year by the weakness of his sight, it yet possesses, in the library which has been judiciously added to it, a treasure which no other institution of the kind can boast, namely, the Herbarium and MSS. of Dillenius and of Sherard, with the collection of books that had belonged to these two *Coryphi.* The first contains almost all the original specimens of Cryptogamia, figured by Dillenius in his work which is now become very scarce; and they are in very good preservation. Perhaps Professor Williams will give us a new edition, with authentic and accurate copies of the plates in this typographical rarity; and add to them the marginal notes of Dillenius. William Sherard not only left to the garden of this University his valuable herbarium, and his rich library which includes some scarce works that are even wanting to that most complete of botanical libraries, the Banksian; but he also bequeathed a sum of 3000*l.* to the University, that with the interest thence arising a Professor of Botany might be supported. It is well known that the first person who received this salary was a German, Dillenius.—A Regius Professor, paid by Government, was appointed in 1793; and this individual was the celebrated Sibthorpe, whose herbarium (now in the hands of Sir J. E. Smith for the publication of the *Flora Græca*) belongs likewise to the University. A circumstance which stamps with increased value the herbaria of Dillenius, Sherard, and Bobart, is, that the two first have, annexed to their well preserved specimens, the synonyms and references of cotemporary authors, particularly those of Plukenet, Petiver, and Sloane, in their respective handwritings, as that of Sibthorpe bears the Linnæan names; by which the very frequent old synonyms are well elucidated. I suggested to Professor Williams the advantage that would arise from causing some young botanists to draw up a complete catalogue of the plants in the collection of Dillenius and Sherard, copying at the same time the synonyms, which after a previous revision might be published. The science of botany, or at least its history, would thus, in my opinion, gain immensely. It is much to be desired, in general, that a list of all the great Herbaria were printed; each plant having its place of growth and first describer noted: this would offer great facilities to the compilers of future monographs on different genera;—at least a person would know where to look for wh. t he might otherwise long seek in vain.

Professor Williams related to me the following anecdote respecting

specting Linnæus, which is traditionally preserved in the Oxford garden, and which deserves to be also known in Germany. Linnæus presented himself at Oxford to Dillenius and Sherard, being then a very young man, and his system having as yet made but little noise in the world of science. The latter received him with cordiality; but Dillenius was very cool, and said to Sherard, "This is the young fellow who is putting all botanists and botany into confusion." Linnæus did not understand the English language, in which this remark was made, but yet he recognized in the word *canfuschjen* (so pronounced by Dillenius in his German accent), the Latin epithet *confusio*. He was silent: Sherard and Dillenius walked up and down in the garden with their new acquaintance, and stopped by a wall overgrown with *Antirrhinum* (*Linaria*) *Cymbalaria*; a plant upon which they were desirous to have the opinion of Linnæus, as much doubt had existed respecting it. Linnæus removed these difficulties with his natural perspicuity. The gentlemen again pointed to a second, and a third plant, of which they felt uncertain; and again the Swede explained the dubious points with perfect ease. Dillenius was surprised; and Sherard observed to him that he could perceive "no confusion at all" in Linnæus. He invited the stranger to dine with him; and during the several days that Linnæus remained in Oxford, he found that the dislike which Dillenius had at first entertained towards him, wore gradually away, and gave place to esteem and friendship. On taking leave, Linnæus remarked to Dillenius, that he should be very sorry to have brought *confusion* into the garden at Oxford. Dillenius blushed, and apologized for the hasty word which had escaped his lips.—I entertained Dr. Williams with an anecdote of Dillenius, in consequence of which this meritorious man is, in Germany, regarded as a kind of simpleton. "Most of my countrymen," replied Dr. Williams, "look upon him as not a hair better."

After having gathered some twigs of trees, planted here by the hands of Dillenius, as a kind of memento of him, we quitted the garden, and followed Professor Williams into his temple the *Bibliotheca Radcliffiana*. A richer collection than this in works of natural history, physic, and medicine, except perhaps that of Sir Joseph Banks, does not exist in any country. —I pass over the description of the beautiful building which contains it, though one of the finest in Oxford; and from the cupola of which a most noble view of the city is obtained, being the situation whence the panorama of Oxford was taken. The foundation of this edifice was laid in 1737, and it was opened in 1749 by the executors of Dr. Radcliffe; who had left to the University a sum of 40,000*l*. to build the library, with

150*l*. a year for the librarian, and 100*l*. annually to purchase new books, and as much more to defray the expense of needful repairs. This income would be quite inadequate to cover the cost of procuring yearly the requisite new publications; but this desirable object has been attained by an arrangement with the Bodleian library. To the latter institution every author in England is by law compelled to send a copy of his book; and the Bodleian has agreed to cede to the Radcliffian library all those upon medico-physical subjects. The experience which, as a naturalist and physician, Dr. Williams possesses, renders his services far more valuable to the institution than the inefficient labours of the learned pedants, to whom the office of librarian is frequently committed. The books are arranged in ethnographical order.

The country between Oxford and Henley, half-way back to London, is so beautiful that we determined to perform this distance on foot. Our expectations of a new Flora were not however realized: except *Ulex europæus*, and in some places a great number of ferns, we met with nothing more interesting than what usually occurs with us. At Henley we took a stage-coach, and passing the villas of Herschel and Banks, arrived in London.

To become properly acquainted with the botanists and state of botany in London would require half a year at least, and we had only half a month in which to attain this object; and were obliged to œconomize every moment, as we had all the hospitals also to visit. We particularly desired to make the acquaintance of Mr. Don; through whose means we hoped to see the Linnæan Society, and the herbarium of Lambert. We had been told so much of the politeness of this learned man, that we hope he will ascribe the great degree of trouble which we occasioned him, to the character for affability which he every where possesses. The preference which the first botanists in London have shown for Mr. Don, by entrusting their treasures to his charge, is as honourable to themselves as to the object of their choice; and the "delightful science" is an equal gainer.

Mr. Don is a man in the flower of his age, and, like all the Scotchmen whom we had the pleasure of knowing in London, a person of remarkable frankness and candour. We are greatly obliged to him for the reception which he was so kind as to give us; he obtained for us a view of the Linnæan Society's apartments, Soho-square: a *Cyathea* from Nepaul stood on the stairs, as high as the house; it might have been used on its voyage to Europe for the mast of a ship. The herbarium is in the hall; very beautifully arranged, with British elegance and

and solidity. The cases in which the animals, chiefly birds, are preserved, are made of the wood of *Flindersia australis.* The rich library of this establishment contains many valuable works, which are wanting to the great universities, academies, and national collections of the continent. The hall in which the meetings of the Society are held, struck us as being a far finer apartment than the House of Commons; and we even thought this latter very inferior to the House of Commons at Munich, which is only used every third year; while again the Hall of Assembly of the Academy at Munich is a mere lumber-room compared with that of the Linnæan Society. The busts of Linnæus and Banks, and of our countryman Trew, and the portraits of Solander and Pulteney, ornament this elegant apartment. All that we were, unfortunately, able to see of Sir J. Banks's herbarium and library was from the windows of the Linnæan Society's house; for Sir Robert Brown was gone to Naples, and had taken with him the key of the Banksian collection*. We were more successful at Count Lambert's, though with the disappointment of not finding at home this venerable sage of seventy years, who has made such sacrifices to botany. He was at his country-seat of Boyton in Wiltshire, some eighty miles, we were told, distant from the capital. Mr. Don, however, had the key to Lambert's *sanctum;* and his goodness afforded us a view of its botanical treasures, accumulated from all parts of the world. The collection of plants contains above 36,000 species; and if its increase continues with its former giant strides, it will soon exceed every other. This immense herbarium, of which the noble proprietor has given some information in the second part of his magnificent work on the genus *Pinus*, consists of no fewer than fifty herbaria, each of which would singly be worth to a botanist more than any pearl in the Mogul's crown. I shall here only mention a few of them, besides the great English one, of the Count's own formation; viz. the plants of Afzelius and Balduinus; the collection made by Baxter in New Holland; the herbaria of Broussonet, Brown (the author of a work on the botany of Jamaica), of Lord Bute, Hill, and Caley (the latter had spent seven years in New Holland); of Cavanilles, Clarke (who had accompanied Cripps); Durandes, Forster, Flinders, Forsyth, Fraser, Gouan, Hamilton (for-

* We really think that it would have been quite an overstretching of that public-spirited liberality, with which both the former and the present proprietor of the Banksian collection have ever opened its treasures to the use of science, if *Sir Robert Brown*, when going to Italy, had thought it necessary to leave the key of Sir J. Banks's library and herbarium in the door.—Ed.

merly known under the name of Buchanan), Hawkins, and Sibthorpe; Hibbert, Hudson, Jack, Captain King, Governor King; a Japanese herbarium (considered as very valuable); the plants of Martin (the well known prize, from which Rudge described his *Flora Guyanensis*); of Masson, Arch, Menzies, of Nuttall (from the Missouri); Pallas, Governor Philipps, Ponthieu's plants from Jamaica; the museum of the Duchess of Portland, Pursh's herbarium, Raffles's, Richardson's (who was with Franklin), Lieut. Roes (Ross's?), Roxburgh's, Ruiz', and Pavon's (Count Lambert paid 1500*l.* for the latter); Sabine's, Seaforth's (from Barbadoes), Sello's, Sieber's, Staunton's, White's (from New South Wales), Wilkins's, Wiles's, &c. &c. If the number of these collections surprises us, the magnificence and variety of the specimens, and the care with which they are preserved,—some under glass, as many of the *Arundinaceæ;* some in pasteboard boxes, others in mahogany cases; while entire branches of several species of *Banksia*, *Dryandra*, and *Protea*, are kept, each in their proper place; with tubes of the *Sarracenia* and *Nepenthes* carefully laid on fine cotton and stuffed with the same material, so as to look as perfect as when growing in the stove,—must excite our still greater admiration. The *Cinchonas*, which are among the grandest of Lambert's favourite tribes, fill three parcels, each probably containing two hundred specimens. This truly noble Count,—who is to England what Count Sternberg is to Bohemia, Count Hoffmannsegg to Saxony, and Baron De Lessert to France,—is still by no means among the number of those English Lords "*quibus Pactolus fluit:*" but with his well employed thousands he has done more for science, and consequently been more useful to mankind, than many with their hundreds of thousands. His name will therefore live in the annals of improvement, and for centuries and centuries be held in grateful remembrance.

Whilst we were employed in viewing Count Lambert's treasures, a little man dressed in black entered the apartment; and he cast a glance full of sorrow and indignation upon some packages which belonged to the herbarium of Ruiz and Pavon. This look attracted my attention, as did the general elevated physiognomy of this person. I could not suppress my curiosity, and asked Mr. Don who this little man might be. When he replied, *Señor Lagasca!* I threw myself into the arms of my old friend, who was much puzzled to imagine who I could be, for we had only known each other by correspondence, which had continued for some years; and here we met, as in a dream, where we least expected to see one another. Poor Lagasca! he had not only lost all his domestic happiness, (his wife and five children

children being in Cadiz,) and his fortune; but also his great herbarium; the manuscript of his Flora of Spain, on which he had been employed for more than twenty years, and which was ready to be printed; even the manuscript of his Monograph of the *Cerealia*, with the dried specimens belonging to it, on which he had laboured at Seville and there completed it,—all, all were destroyed! He saved nothing from the great shipwreck of that Cortes to which his talents and virtue had raised him, but his own life. Far from his beautiful country, and from his beloved relations, he now lives in the foggy and expensive London, where he participates in the afflictions of so many of his worthy and exiled countrymen!

Lagasca and I met almost daily after this interview, and made some botanical excursions together: among other places, to the celebrated gardens of Kew. We did not see Mr. Townsend Aiton, as he had been called away to Windsor; but in this well known garden, whose Catalogue has given it so much celebrity, we did not find the pleasure that we had anticipated. We were disappointed particularly in the plants which grow in the open air, which are not so accurately named as those in the Göttingen Botanic Garden, superintended by Schrader: sometimes the same species is marked with two different names. The garden at Kew consists of a fine park, and a large botanical garden of about twenty acres. What we usually term a park in Germany is like anything rather than what receives the same appellation in England; and which is neither more nor less than a wood, in which nature and art seem to dispute for the original formation and present possession. As in a wood, one may walk, ride and drive about it, without risk of interruption. English parks are in fact beautiful woods, and nothing more; and it will ever remain one of the most difficult problems in the delightful science of laying out pleasure-grounds, so to plan a charming wood, as that he who is in it shall not know whether he be in a grove or a house. We have on the continent many exquisitely formed gardens, under the name of English ones; but an English park I have only seen in England. The Botanic Garden at Kew is surrounded by high walls, and intersected into long squares. With regard either to its plan, or its nine or ten stoves, it will not bear a comparison with those of Malmaison, or the Grand Duke of Weimar, of Prince Esterhazy at Eisenstadt, or even with the botanical division of the Imperial Garden at Schönbrunn. A Supplement to the *Hortus Kewensis*, under the inspection of Sir Robert Brown, will soon be published: many species which were formerly cultivated here, are said to be lost. Our countryman, the celebrated flower-painter, Mr. Francis Bauer, with whom

whom I had the honour of being acquainted some years since at Vienna, resides at Kew. I regretted his absence from home when I called to pay my respects to him.

[To be continued.]

LVII. *On the Action of a Flame urged by the Blowpipe on other Flames.* By Mr. THOMAS ANDREWS.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

ALTHOUGH the action of the flame produced by the blast of the blowpipe has been tried upon almost every substance which could be exposed to it, yet its influence upon flame itself has never I believe been examined*.—I directed the flame of a candle urged by a mouth blowpipe upon that of another candle of equal size, so that the extremity of the reducing flame of the first candle played on the flame of the other, in the same manner as the orifice of a blowpipe. On applying the blast, the flame of the second or remote candle was inverted, and exhibited nearly the same appearances as a flame acted on immediately by the blowpipe; the reducing part of it terminated in a perfect conical shape, and beyond it the oxidizing part appeared of a similar form. The reducing flame, however, formed by this means was considerably larger than that formed by the blowpipe in the usual manner; and from some comparative experiments which I made, its heating power appeared to be scarcely so great. I approached the second candle to the first, till the reducing flame of the latter penetrated beyond the flame of the former: in this case the reducing flame was terminated by irregular points, and its outlines were indistinctly marked. On removing the flame of the second candle into the oxidizing part of the first, the former was inverted as in the other cases, but the reducing part of it terminated not in a point but in a luminous zone. This latter experiment will succeed even when the flames of the two candles are six inches distant; but beyond that point an irregular waving is only produced in the second flame. It is evident, however, that this point will vary according to the flame which is employed.

Instead of two, I have placed six different flames in the same manner in succession, and the last of them seemed to be in-

* In the case of the spirits of wine colipile, the impetuosity with which the vapour of the spirits issues from the orifice of the tube prevents the action of the flames on each other from being observed.

verted

verted equally with the first; from which it would appear, that any number of flames might by this means be directed by a single blast.

The action of the one flame in directing the others may be strikingly exemplified by removing the flame in immediate contact with the blowpipe during the blast; for the rest will be then affected only by an irregular unsteady motion. In like manner, if we fuse a small piece of metallic tin or lead in the reducing part of the remote flame, and then remove that flame, the metal will instantly be converted into an oxide.

By inserting the above in the Philosophical Magazine and Annals of Philosophy, you will oblige yours, &c.

Belfast, Oct. 5, 1829. THOMAS ANDREWS.

LVIII. *On the Action of Potash on Organic Matter.* By M. GAY-LUSSAC*.

M. VAUQUELIN found, on treating pectic acid with potash in a crucible, that it was converted into oxalate of potash. This experiment suggested to me the idea of submitting ligneous matter to similar treatment. Five gr. of cotton were put into a platina crucible with 25 gr. of potash, and a little water. The crucible was moderately heated with a spirit-lamp, and much below redness. The cotton resisted for some time the action of the potash, but it eventually softened; the mixture swelled without carbonizing, and the action of the alkali upon the ligneous matter was discoverable by the disengagement of hydrogen. During the swelling the mixture ought to be continually stirred. When it becomes thick, the mass is dissolved in water, and slightly supersaturated with nitric acid; it then gives an abundant precipitate with nitrate of lead, which, treated with sulphuretted hydrogen, produces very fine crystals of oxalic acid. With nitrate of lime, a bulky precipitate of oxalate of lime is obtained. Sawdust similarly treated gave the same results. Sugar mixed with four or five times its weight of potash, became at first brown; but afterwards white, and it yielded much oxalic acid. Starch forms a very glutinous mass, and remains long in that state. The addition of a fresh quantity of potash occasions liquefaction; the mixture swells and is converted into oxalate of potash: gum and sugar of milk are also converted into oxalic acid, with the evolution of hydrogen gas.

One of the most singular of these conversions into oxalic

* From *Annales de Chimie*, Aug. 1829.

acid,

acid, is that of tartaric acid. No intumescence occurs, the mixture does not blacken, and what is very remarkable is, that so small a quantity of hydrogen is disengaged, that it must be supposed to be derived from a minute quantity of foreign vegetable matter. When the hydrogen is to be collected, the experiment must be made in a retort, to which a long glass tube is to be adapted, and this is to be immersed beneath a stratum of water in a little mercury, to prevent absorption. The retort may be heated in an oil or mercurial bath, to about the temperature of 200° Centig., which is quite sufficient to form oxalic acid.

Citric and mucic acid also produce much oxalic acid. I also obtained some from succinic acid; but benzoic acid resisted the action of the potash and remained unaltered. Acetate of potash heated with excess of potash, was converted into carbonate. I nevertheless obtained a little oxalate of lime when I poured nitrate of lime into a solution of the residual mass, after having saturated it with acetic acid; but it is very probable that the oxalic acid was derived from a small quantity of foreign vegetable matter.

Expressed vegetable oil treated with great excess of potash did not undergo fusion. I obtained only a very small quantity of oxalic acid.

Animal substances, such as silk, treated with potash, gave oxalic acid, attended with the evolution of hydrogen. Uric acid evolved ammonia during the operation. The remaining mixture was very white. Dissolved in water and saturated with nitric acid, it gave out hydrocyanic acid and much carbonic acid; nitrate of lime afterwards produced an abundant precipitate of oxalate of lime in the solution. Gelatin gave a similar result, but with indigo I did not perceive any oxalic acid. Carbonate of potash being substituted for caustic, did not produce oxalic acid with tartar. Lime and starch did not form any, but soda was advantageously substituted for potash.

It results from these experiments, that a great number of vegetable and animal substances, when treated with caustic potash or soda, are converted into oxalic acid. It is to be observed that the formation of this acid precedes that of carbonic acid, precisely in the same circumstances as those in which sulphur and potash, for example, produce hyposulphurous acid and sulphuric acid;—thus a vegetable substance, when moderately heated with potash will give oxalic acid, and when more strongly heated, carbonic acid.

As very different organic bodies thus produce oxalic acid, other products are necessarily formed. Many vegetable bodies give

give hydrogen, which must come from the substance itself or from water, and at last they yield carbonic acid. Animal matters, besides these products, give ammonia and cyanogen. Water may also be formed with animal, as well as with vegetable substances. These various products, or merely some of them, are sufficient to explain in general the formation of oxalic acid; nevertheless in some particular cases, it would appear that other products must be obtained: thus tartaric acid yielding no sensible quantity of hydrogen, we cannot, considering its composition as

$2\frac{1}{2}$ proportions of hydrogen,
4 ——— of carbon,
5 ——— of oxygen,

explain its conversion into oxalic acid, except by the formation of the probable compound already mentioned.

In fact, during the operation the mass remains white, and does not carbonize. If all the carbon entered into the composition of the oxalic acid, it would require six proportions of carbon; and consequently the water must be decomposed to supply one proportion. If only such a quantity of oxalic was formed, as is proportional to the oxygen contained in the tartaric acid, there would remain two-thirds of a proportion of carbon which might form a peculiar compound with the hydrogen, and for one proportion of tartaric acid, $1\frac{2}{3}$ proportion of oxalic acid would be procured. I did in fact obtain, at least $1\frac{1}{3}$; but I have not yet discovered any other hydrogenated product. Lastly, it is possible that with carbon, hydrogen and oxygen, a peculiar acid might be formed. This subject, it will be admitted, requires additional examination. I conclude by mentioning a very elegant process for converting tartar into oxalate of potash.—It consists in dissolving crude tartar in water, with a proper quantity of potash or soda, and passing the solution continually through a thick iron tube by means of a pump, at a temperature of 200° to 225° Centig. The pressure will not exceed twenty-five atmospheres, because no gas will be evolved. A valve placed at the end opposite to that at which the solution enters, is to be loaded with a weight sufficient to produce this pressure, and it will open only by the contrary pressure of the injecting pump. I have not yet tried this process, which may also be applied to other substances; but I see nothing which opposes its success. According to some experiments which I have made, it requires less than one proportion of potash for one proportion of neutral tartrate.

LIX.—*Historical Eloge of the Marquis De Laplace**.—By M. Le Baron Fourier.

THE name of Laplace has been heard in every part of the world where the sciences are honoured; but his memory could not receive a more worthy homage than the unanimous tribute of the admiration and sorrow of that illustrious body who shared in his labours and in his glory. He consecrated his life to the study of the grandest objects which can occupy the human mind.

The wonders of the heavens,—the lofty questions of natural philosophy,—the ingenious and profound combinations of mathematical analysis,—all the laws of the universe have been presented to his thoughts during more than sixty years, and his efforts have been crowned with immortal discoveries.

From the time of his first studies it was remarked that he possessed a prodigious memory: all the occupations of the mind were easy to him. He acquired rapidly a very extensive knowledge of the ancient languages, and he cultivated different branches of literature.—Every thing interests rising genius; every thing is capable of revealing it. His earliest success was in theological studies; and he treated with talent and with extraordinary sagacity the most difficult controversial questions.

We do not know by what fortunate event Laplace passed from the study of scholastics to that of the higher geometry. This last science, which scarcely admits of a divided attention, attracted and fixed his thoughts. Henceforth he abandoned himself without reserve to the impulse of his genius, and he was impressed with the conviction that a residence in the capital had now become necessary. D'Alembert was then in the zenith of his fame. It was he who informed the court of Turin that its Royal Academy possessed a geometer of the first order—Lagrange, who, without this noble testimony to his merits, might have remained long unknown. D'Alembert had announced to the king of Prussia that there was only one man in Europe who could replace at Berlin the illustrious Euler, who, having been recalled by the Russian government, had consented to return to St. Petersburg. I find in the unpublished letters possessed by the Institute of France the details of this glorious negociation, which fixed the residence of Lagrange at Berlin.

* Pronounced at the public sitting of the Royal Academy of Sciences on the 15th June 1829.

It

It was about the same time that Laplace began that long career which was destined to become so illustrious.

He waited upon D'Alembert, preceded by numerous recommendations, which might have been considered as very powerful. But his attempts were vain, for he was not even introduced. He then addressed to him whose suffrage he solicited a very remarkable letter on the general principles of mechanics, of which M. Laplace has frequently quoted to me different fragments. It was impossible that a geometer like D'Alembert could fail to be struck with the singular profoundness of this composition. On the same day he invited the author of the letter, and thus addressed him:—"You see, Sir, that I hold recommendations as of very little value;—you have no occasion for them. You have made yourself better known;—this is sufficient for me: You are entitled to my support." In a few days he succeeded in getting Laplace nominated Professor of Mathematics in the Military School of Paris. From that moment, devoted wholly to the science which he had chosen, he gave to all his labours a fixed direction, from which he never deviated; for the unchangeable purpose of his mind has always been the principal feature of his genius. He already trenched upon the known limits of mathematical analysis;—he was versed in the most ingenious and powerful parts of this science; and there was none more capable than he of extending its domains. He had solved a leading question in theoretical astronomy. He formed the project of consecrating his efforts to this sublime science;—he was destined to perfect it, and was able to embrace it in all its extent. He thought deeply upon his glorious purpose; and he spent his whole life in accomplishing it, with a perseverance of which the history of the sciences presents perhaps no other example.

The immensity of the subject flattered the just pride of his genius. He undertook to compose the Almagest of his age. This memorial he has left us under the name of the *Mécanique Céleste;* and his immortal work surpasses that of Ptolemy as much as the modern analysis surpasses the *Elements of Euclid.*

Time, which is the only just dispenser of literary glory, and which sinks into oblivion contemporary mediocrity, perpetuates also the remembrance of great works. They alone convey to posterity the character of each succeeding age. The name of Laplace will thus live for ever;—but I hasten to add, that enlightened and impartial history will never separate his memory from that of the other successors of Newton. It will conjoin the illustrious names of D'Alembert, Clairaut, Euler,

 Lagrange,

Lagrange, and Laplace. I confine myself at present to the mere mention of the great geometers whom the sciences have lost, and whose researches had for their common object the perfection of physical astronomy.

In order to give a just idea of their works, it would be necessary to compare them; but the limits of a discourse like this oblige me to reserve a part of this discussion for the collection of our Memoirs.

Next to Euler, Lagrange contributed most to the foundation of mathematical analysis. In the writings of these two great geometers it has become a distinct science, the only one of the mathematical theories of which we can say that it is completely and rigorously demonstrated. Among all these theories, it alone is sufficient for its own purposes, while it illustrates all the rest; and it is so necessary to them, that without its aid they must have remained very imperfect.

Lagrange was destined to invent and to extend all the sciences of calculation. In whatever condition fortune had placed him, whether prince or peasant, he would have been a great geometer. This he would have become necessarily and without any effort—which cannot be said even of the most celebrated individuals who have excelled in this science.

If Lagrange had been the contemporary of Archimedes and Conon, he would have divided with them the glory of their most memorable discoveries. At Alexandria he would have been the rival of Diophantus.

The distinctive mark of his genius consists in the unity and grandeur of his views. He attached himself wholly to a simple though just and highly elevated thought. His principal work, the *Mécanique Analytique*, might be called Philosophical Mechanics, for it refers all the laws of equilibrium and motion to a single principle; and, what is not less admirable, it submits them to a single method of calculation of which he himself was the inventor. All his mathematical compositions are remarkable by their singular elegance, by symmetry of form, and generality of method, and, if we may so express it, by the perfection of his analytical style.

Lagrange was no less a philosopher than a great geometer. He has proved this in the whole course of his life, by the moderation of his desires, by his immoveable attachment to the general interests of humanity, by the noble simplicity of his manners, and the elevation of his character, and by the justness and profoundness of his scientific labours.

Laplace had received from nature all that force of genius which a great enterprise required. Not only has he united in his Almagest of the eighteenth century all that the mathematical

and

and physical sciences had already invented, and which formed the foundation of astronomy, but he has added to this science capital discoveries of his own which had escaped all his predecessors. He has resolved, either by his own methods or by those of which Euler and Lagrange had pointed out the principles, questions the most important, and certainly the most difficult of all those which had been considered before his time. His perseverance triumphed over every obstacle. When his first efforts were not successful, he renewed them under the most ingenious and diversified forms.

In the motions of the moon, for example, there had been observed an acceleration, the cause of which philosophers were unable to discover. It had been ascribed to the resistance of an ethereal medium in which the celestial bodies moved. If this had been the case, the same cause affecting the orbits of the planets would have tended continually to disturb their primitive harmony. These stars would have been constantly disturbed in their course, and would have finally been precipitated upon the mass of the sun. It would have required the creating power to have been exerted anew in preventing or repairing the immense disorder which the lapse of time would have caused.

This cosmological question is undoubtedly the greatest which human intelligence can propose: It is now resolved. The first researches of Laplace on the immutability of the dimensions of the solar system, and his explanation of the secular equation of the moon, have led to this solution.

He at first inquired if the acceleration of the moon's motion could be explained by supposing that the action of gravity was not instantaneous, but subject to a successive transmission like that of light. By this means he succeeded in discovering its true cause. A new investigation then gave a better direction to his genius. On the 19th March 1787, he communicated to the Academy of Sciences a precise and unexpected solution of this great difficulty. He proved in the clearest manner that the observed acceleration is a necessary effect of universal gravitation.

This great discovery threw a new light on the most important points of the system of the world. The same theory, indeed, proved to him, that, if the action of gravitation on the stars was not instantaneous, we must suppose that it propagates itself more than fifty millions of times faster than light, whose velocity is well known to be 70,000 leagues in a second.

Hence he concluded from his theory of the lunar motions, that the medium in which the stars revolve does not oppose

any

any sensible resistance to the motions of the planets; for this cause would particularly affect the motion of the moon, whereas it produces no perceptible effect.

The discussion of the motions of this planet is pregnant with remarkable consequences. We may conclude from it, for example, that the motion of rotation of the earth about its axis is invariable. The length of the day has not varied the 100dth part of a second for 2000 years. It is remarkable that an astronomer need not go out of his observatory to measure the distance of the earth from the sun. It would be sufficient to observe carefully the variations of the lunar motions, and from this he would deduce with certainty the distance required.

A still more striking consequence is that which relates to the figure of the earth; for the form even of the terrestrial globe is impressed on certain inequalities of the lunar orbit. These inequalities would not have taken place if the earth had been a perfect sphere. We may determine the compression at the poles of the globe by the observation of the lunar motions alone; and the results hence deduced agree with the real measures which have been obtained by the great trigonometrical surveys at the equator, in the northern regions, in India, and in different countries.

It is to Laplace that we especially owe this astonishing perfection of modern theories.

I cannot undertake to recount at present the series of his labours, and the discoveries to which they have led. The simple enumeration of them, however rapid it may be, would exceed the limits which I am obliged to prescribe to myself. Beside these researches on the secular equation of the moon, and the no less important and difficult discovery of the cause of the great inequalities of Jupiter and Saturn, we may mention those admirable theorems on the libration of the satellites of Jupiter. To these we may add his analytical inquiries respecting the tides,—a subject which he has pursued to an immense extent.

There is scarcely a point of physical astronomy of any importance that he did not study with the most profound attention; and he submitted to calculation most of the physical conditions which his predecessors had omitted. In the question already so complex, of the form and rotatory motion of the earth, he has considered the influence of the waters distributed between the continents, the compression of the interior strata, and the secular diminution of the dimensions of the globe.

Among all these researches we must particularly distinguish those

those which relate to the stability of great phænomena; for no object is more worthy of the meditation of philosophers. Hence it follows that those causes, either accidental or constant, which disturb the equilibrium of the ocean, are subject to limits which cannot be passed. The specific gravity of the sea being much less than that of the solid globe, it follows that the oscillations of the ocean are always comprehended between very narrow limits; which would not have happened if the fluid spread over the globe had been much heavier. Nature in general keeps in reserve conservative forces which are always present, and act the instant the disturbance commences, and with a force increasing with the necessity of calling in their assistance. This preservative power is found in every part of the universe. The form of the great planetary orbits, and their inclinations, vary in the course of ages, but these changes have their limits. The principal dimensions subsist, and this immense assemblage of celestial bodies oscillates round a mean condition of the system, towards which it is always drawn back. Every thing is arranged for order, perpetuity, and harmony.

In the primitive and liquid state of the terrestrial globe, the heaviest materials are placed near the centre, and this condition determines the stability of seas.

Whatever may be the physical cause of the formation of the planets, it has impressed on all these bodies a projectile motion in one direction round an immense globe; and from this the solar system derives its stability. Order is here kept up by the power of the central mass. It is not, therefore, left, as Newton himself and Euler had conjectured, to an adventitious force to repair or prevent the disturbance which time may have caused. It is the law of gravitation itself which regulates all things, which is sufficient for all things, and which everywhere maintains variety and order. Having once emanated from Supreme Wisdom, it presides from the beginning of time, and renders impossible every kind of disorder. Newton and Euler were not acquainted with all the perfections of the universe.

Whenever any doubt has been raised respecting the accuracy of the Newtonian law, and whenever any foreign cause has been proposed to explain apparent irregularities, the original law has always been verified after the most profound examination. The more accurate that astronomical observations have become, the more conformable have they been to theory. Of all geometers Laplace is the one who has examined most profoundly these great questions.

We cannot affirm that it was his destiny to create a science entirely

entirely new, like Galileo and Archimedes; to give to mathematical doctrines principles original and of immense extent, like Descartes, Newton, and Leibnitz; or, like Newton, to be the first to transport himself into the heavens, and to extend to all the universe the terrestrial dynamics of Galileo: but Laplace was born to perfect every thing, to exhaust every thing, and to drive back every limit, in order to solve what might have appeared incapable of solution. He would have completed the science of the heavens, if that science could have been completed.

The same character appears in his researches on the analysis of probabilities,—a science quite modern and of immense extent; whose object, often misunderstood, has given rise to the most erroneous interpretations, but whose application will one day embrace every department of human knowledge,—a fortunate supplement to the imperfection of our nature.

This art originated from a fine and fertile idea of Pascal's: It was cultivated from its origin by Fermat and Huygens. A philosophical geometer, James Bernouilli, was its principal founder. A singularly happy discovery of Stirling, the researches of Euler, and particularly an ingenious and important idea due to Lagrange, have perfected this doctrine: It has been illustrated by the objections even of D'Alembert, and by the philosophical views of Condorcet: Laplace has united and fixed the principles of it. In his hands it has become a new science, submitted to a single analytical method, and of prodigious extent. Fertile in useful applications, it will one day throw a brilliant light over all the branches of natural philosophy. If we may here be permitted to express a personal opinion, we may add, that the solution of one of the principal questions, that which the illustrious author has treated in the 18th chapter of his work, does not appear to us exact; but, taken all in all, this work is one of the most precious monuments of his genius.

After having mentioned such brilliant discoveries, it would be useless to add, that Laplace belonged to all the great Academies of Europe.

I might also, and perhaps ought to, mention the high political dignities with which he was invested; but such an enumeration would only have an indirect reference to the object of this discourse. It is the great geometer whose memory we now celebrate. We have separated the immortal author of the *Mécanique Céleste* from all accidental facts which concern neither his glory nor his genius. Of what importance indeed is it to posterity, who will have so many other details to forget, to learn whether or not Laplace was for a short time the

minister

minister of a great nation. What is of importance are the eternal truths which he discovered;—the immutable laws of the stability of the world, and not the rank which he occupied for a few years in the conservative senate.—What is of importance, and perhaps still more so even than his discoveries, is the example which he has left to all those who love the sciences, and the recollection of that incomparable perseverance which has sustained, directed, and crowned so many glorious efforts.

I shall omit, therefore, all the accidental circumstances and peculiarities which have no connection with the perfection of his works. But I will mention, that in the first body in the state the memory of Laplace was celebrated by an eloquent and friendly voice, which important services rendered to the historical sciences, to literature, and to the state, have for a long time illustrated *.

I shall particularly mention that literary solemnity which attracts the attention of the capital. The French Academy, uniting its suffrages to the acclamations of the country, considered that it would acquire a new glory by crowning † the triumphs of eloquence and of political virtue.

At the same time it chose to reply to the successor of Laplace, an illustrious academician ‡, with more than one claim, who united in literature, in history, and in the public administration, every species of talent.

Laplace enjoyed an advantage which fortune does not always grant to great men. From his earliest youth he was justly appreciated by his illustrious friends. We have now before us unpublished letters, which exhibit all the zeal of D'Alembert to introduce him into the Military School of France, and to prepare for him, if it had been necessary, a better establishment at Berlin. The president Bochard de Saron caused his first works to be printed. All the testimonies of friendship which have been given to him recall great labours and great discoveries; but nothing could contribute more to the progress of the physical sciences than his relations with the illustrious Lavoisier, whose name, consecrated in the history of science, has become an eternal object of our sorrow and esteem.

These two celebrated men united their efforts. They undertook and finished very extensive researches in order to measure one of the most important elements of the physical theory of heat. About the same time, they also made a long series of experiments on the dilatation of solid substances. The

* M. Le Marquis Pastoret. † M. Royer-Collard.
‡ M. Le Comte Daru.

works of Newton sufficiently show us the value which this great geometer attaches to the special study of the physical sciences. Laplace is of all his successors the one who has made the greatest use of his experimental method; he was almost as great a natural philosopher as he was a geometer. His researches on refractions, on capillary attraction, on barometrical measurements, on the statical properties of electricity, on the velocity of sound, on molecular action, and on the properties of gases, testify that there was nothing in the investigation of nature to which he was a stranger. He was particularly anxious about the perfection of instruments, and he caused to be constructed at his own expense, by a celebrated artist, a very valuable astronomical instrument, which he gave to the Observatory of France.

All kinds of phænomena were perfectly well known to him. He was connected by an old friendship with two celebrated chemists, whose discoveries have extended the boundaries of the arts and of chemical theory. History will unite the names of Berthollet and Chaptal to that of Laplace. It was his happiness to reunite them; and their meetings always had for their object and for their results the increase of those branches of knowledge, which are the most important and the most difficult to acquire.

The gardens of Berthollet at his house at Arcueil were not separated from those of Laplace. Great recollections and great sorrows have rendered this spot illustrious. It was there that Laplace received celebrated foreigners, men of powerful minds, from whom science had either obtained or expected some benefit, but especially those whom a sincere zeal attached to the sanctuary of the sciences. The one had begun their career,—the others were about to finish it. He received them with extreme politeness: He went even so far that he led those who did not know the extent of his genius, to believe that he might himself draw some advantage from their conversation.

In alluding to the mathematical works of Laplace, we have particularly noticed the depth of his researches, and the importance of his discoveries: but his works are distinguished also by another character which all readers have appreciated, —I mean the literary merit of his compositions. That which is entitled the *Systême du Monde* is remarkable for the elegant simplicity of its style, and the purity of its language. There had previously been no example of this kind of composition; but we should form a very incorrect idea of the work, were we to expect to acquire a knowledge of the phænomena of the heavens in such productions. The suppression of the symbols of the language of calculation cannot contribute

bute to its perspicuity, and render the perusal of it more easy. The work is a perfectly regular exposition of the results of profound study: it is an ingenious epitome of the principal discoveries. The precision of its style, the choice of methods, the greatness of the subject, give a singular interest to this vast picture; but its real utility is to recall to geometers those theorems whose demonstrations were already known to them. It is properly speaking the contents of a mathematical treatise.

The purely historical works of Laplace have a different object. They present to geometers with admirable talent the progress of the human mind in the invention of the sciences. The most abstract theories have indeed an innate beauty of expression. It is this which strikes us in several of the treatises of Descartes, and in some of the pages of Galileo, of Newton, and Lagrange. Novelty of views, elevation of thought, and their connection with the grand objects of nature, fix the attention and fill the mind. It is sufficient that the style be pure, and have a noble simplicity. It is this kind of literature that Laplace has chosen, and it is certain that he has attained in it the first rank. If he writes the history of great astronomical discoveries, he becomes a model of elegance and precision. No leading fact ever escapes him: the expression is never obscure or ambiguous. Whatever he calls great is great in reality. Whatever he omits does not deserve to be cited.

M. Laplace retained to a very advanced age that extraordinary memory which he had exhibited from his earliest years; a precious gift, which, though it is not genius, is that which serves to acquire and preserve it. He had not cultivated the fine arts, but he appreciated them. He was fond of Italian music and of the poetry of Racine, and he often took delight in quoting from memory different passages of this great poet. The works of Raphael adorned his apartments, and they were found beside the portraits of Descartes, Francis Vieta, Newton, Galileo and Euler.

Laplace had always accustomed himself to a very light diet, and he diminished the quantity of it continually, and even to an excessive degree. His very delicate sight required constant care, and he succeeded in preserving it without any alteration. These cares about himself had only one object, that of reserving all his time and all his strength for the labours of his mind. He lived for the sciences, and the sciences have rendered his memory immortal.

He had contracted the habit of excessive application to study, so injurious to health, though so necessary to profound inquiries; but he did not experience from it any inconvenience till during the two last years of his life.

At the commencement of the disease by which he was cut off, there was observed with alarm a moment of delirium. The sciences still occupied his mind. He spoke with an unwonted ardour of the motions of the planets, and afterwards of a physical experiment, which he said was a capital one; and he announced to the persons whom he believed to be present, that he would soon discuss these questions in the Academy. His strength gradually failed. His physician *, who deserved all his confidence, both from his superior talents and the care which friendship alone could have inspired, watched near his bed; and M. Bouvard, his fellow-labourer and his friend, never left him for a single moment.

Surrounded with a beloved family,—under the eyes of a wife whose tenderness had assisted in supporting the necessary ills of life, whose amenity and elegance had shown him the value of domestic happiness, he received from his son, the present Marquis de Laplace, the strongest proofs of the warmest affection.

He evinced his deep gratitude for the marks of interest which the King and the Dauphin had repeatedly exhibited.

Those who were present at his last moments reminded him of his titles to glory, and of his most brilliant discoveries. He replied, "What we know is little, and what we are ignorant of is immense." This was at least the meaning of his last words, which were articulated with difficulty. We have often heard him express the same thought, and almost in the same terms. He grew weaker and weaker, but without suffering pain.

His last hour had arrived: the powerful genius which had for a long time animated him, separated from its mortal coil, and returned to the heavens.

The name of Laplace honoured one of our provinces already so fertile in great men,—ancient Normandy. He was born on the 23d March 1749, and he died in the 78th year of his age, on the 5th May 1827, at nine o'clock in the morning. Shall I remind you of that gloomy sadness which brooded over this place like a cloud when the fatal intelligence was announced to you? It was on the day and even at the hour of your usual meetings. Each of you preserved a mournful silence; each felt the sad blow with which the sciences were struck. All eyes were fixed on that place which he had so long occupied among you. One thought only filled your minds; every other meditation became impossible. You separated under the influence of an unanimous resolution, and for this single time your usual labours were interrupted.

* M. Magendie.

It

It is doubtless great—it is glorious—it is worthy of a powerful nation to decree high honours to the memory of its celebrated men. In the country of Newton the ministers of state desired that the mortal remains of this great man should be solemnly deposited among the tombs of its monarchs. France and Europe have offered to the memory of Laplace an expression of their sorrow, less pompous no doubt, but perhaps more touching and more sincere.

He has received an unusual homage;—he has received it from his countrymen in the bosom of a learned body, who could alone appreciate all his genius. The voice of science in tears was heard in every part of the world where philosophy had penetrated. We have now before us an extensive correspondence from every part of Germany, England, Italy, and New Holland—from the English possessions in India, and from the two Americas—and we find in it the same expressions of admiration and sorrow. This universal grief of the sciences, so nobly and so freely expressed, has in it no less truth than the funeral pomp of Westminster Abbey.

Permit me, before closing this discourse, to repeat a reflection which presented itself when I was enumerating in this place the great discoveries of Herschel, but which applies more directly to Laplace.

Your successors will see accomplished those great phænomena whose laws he has discovered. They will observe in the lunar motions the changes which he has predicted, and of which he was alone able to assign the cause. The continued observation of the satellites of Jupiter will perpetuate the memory of the inventor of the theorems which regulate their course. The great inequalities of Jupiter and Saturn pursuing their long periods, and giving to these planets new situations, will recall without ceasing one of the most astonishing discoveries. These are the titles to true glory which nothing can extinguish. The spectacle of the heavens will be changed; but at these distant epochs the glory of the inventor will ever subsist; the traces of his genius bear the stamp of immortality.

I have thus presented to you some features of an illustrious life consecrated to the glory of the sciences. May your recollection supply the defects of accents so feeble! May the voices of the nation—may that of the world at large, be raised to celebrate the benefactors of nations—the only homage worthy of those who, like Laplace, have been able to extend the domains of thought—to attest to man the dignity of his being, by unveiling to his eyes all the majesty of the heavens!

LX. *Pro-*

LX. *Proceedings of Learned Societies.*

ROYAL ACADEMY OF SCIENCES OF PARIS.

April 20.—M. LIONVILLE sent a fresh memoir On the physical theory of electro-dynamic phænomena. M. Robert wrote from Marseilles, in answer to a letter of Dr. Berlan's to the Academy, that he had never attributed to himself the discovery claimed, and that he well knew that it had been said before he observed it, that vaccinated persons have been sometimes subject to the small-pox.—M. Wauner, M.D. deposited a sealed packet.—M. Cagniart La Tour communicated the methods by which he crystallized silica.—M. Robiquet presented a memoir, intitled, *Essai Analytique des Lichens de l'Orseille.*

The Academy proceeded, according to rule, to a scrutiny of the balloting between MM. Becquerel and Pouillet. The number of voters was 57; M. Becquerel had 29, and M. Pouillet 28 votes.—M. Cordier gave an account of the examination which he had made with M. Beudant, of the precious stones presented by M. Le Gigand: it appeared that the stones in question were white topazes, and not diamonds.—M. Desfontaines, in the name of a commission, gave a favourable account of the work presented by M. Cambessède on the family of the *Sapindaceæ.*—M. Poisson read a memoir On the mean results of observations.—M. Magendie, in the name of a commission, reported on a memoir of M. Leroy d'Etioles relating to Asphyxia. M. Leroy stated, that by strongly forcing atmospheric air into the trachea of certain animals, such as hares, goats, sheep, foxes, &c. they were immediately killed. Other animals, dogs for example, in which the pulmonary tissue is less delicate, resist this operation; but they are more or less incommoded by it. Goats and sheep were immediately killed in the presence of the commissioners, by once blowing air into their lungs, without the use of any machine, and simply by the mouth of the experimenter. It appears, generally, that the air blown in, tears the superior part of the delicate tissue of the lung. Inflation being recommended as an efficacious method of restoring drowned persons, it is extremely important to ascertain whether the lungs of man should be classed with those of the sheep, goat, &c. or whether they are capable of resistance similar to that of the lungs of dogs, &c.: it is conceived, that in the first case, inflation effected without great care, may become a mortal agent. On this subject, direct experiments are wanting: but experiments made on the dead subject showed that the lungs of man are capable of being torn by inflation; on the contrary, the lungs of very young children resisted the action of very strong inflation.

April 27.—*Manuscripts presented:—Trattato sul Ochio umano,* by Dr. Rivelli;—Ordonnance of the king confirming the nomination of M. Olbers as an associate;—Protest of M. Le Gigand against the report of M. Cordier;—Letter from M. Julia Fontenelle, containing two facts, from which it appears to result, agreeably to the experiments mentioned in the last sitting, that the lungs of children resist inflation better than those of adults;—A letter from M. Domet-Demont on the lithographic stones of Jura.

The

The Commission appointed to decree the mathematical prizes, announced, that M. Pontecoulant's memoir On the perturbation of comets, was worthy of being crowned.—M. Fred. Cuvier gave an account of M. Guerin's Atlas of the Animal Kingdom.—M. Arago communicated Magnetic observations made at Kassan by M. Kuppfer; and from which it appears that the horizontal needle was deranged by the aurora borealis on the same days as at Paris. He afterwards read a letter which he had received from M. De Bréauté, on an earthquake felt in the neighbourhood of Dieppe during the night of the 1st and 2nd of last April. The same member, in the name of a commission, made a report on the Voyage of the Chevrette.—The sitting was terminated by a memoir of M. Vauquelin, On Carrots; and by reading an addition to M. Cauchy's memoir On the linear dilatation and condensation of solid bodies.

LXI. *Intelligence and Miscellaneous Articles.*

IMPROVEMENTS IN THE MANAGEMENT OF MINES.

THE following Address was delivered by John Taylor, Esq. of Coed-dû, near Mold, at a public dinner at Holywell, given to him by the various gentlemen interested in Mines and Manufactures in the counties of Flint, Denbigh, Chester, and Lancaster.—P. D. Cooke, Esq. in the Chair.

Mr. Chairman,—The improvements in the management of mines, which you have complimented me by associating with my name, have, I consider, arisen out of circumstances which demanded them; have, like all other progressions of the human mind, been advanced by various persons, and have been fostered and encouraged by favourable coincidences. My own experience of mining during a period of more than 30 years, has enabled me to witness their progress, and to contemplate their effect: if it has also empowered me to be the channel of communication, by which their advantages have been extended to this most important mining district, I shall feel as much honoured by this distinction, as I am gratefully affected by the distinguished mark of your opinion upon the subject, and the notice you have taken of the humble effort of an individual. I feel, that if this district, so early celebrated for its mineral riches, has been more tardy than some other parts of the kingdom in developing its resources, it is only because they have not been called for, because the necessity which has stimulated the miners of Cornwall did not exist here. And now when the time has come that treasures are to be explored, we shall see whether the miners of North Wales will not know how to profit by the experience of others; and having discernment to see what is good, will adopt the most salutary measures, and carry them forward with the modifications and improvements which will best adapt them to the different circumstances of their mines and habits of their people. That the mines of Cornwall should take a lead in the means of overcoming the difficulties that nature presents, to the pursuit of the metals, was almost a matter of course, inasmuch

as

as those difficulties presented themselves in that district at a very early period.

Mining, as long as deposits of ore are found in veins at shallow depths, and in masses more or less rich, is comparatively easy to conduct, and the profits would appear to depend as much upon chance as upon any systematic plan of operations. The knowledge it required need not be very extensive, and was often thought to be rather of an empirical than of a more liberal character; experience had, however, been acquired by many, and was used, as it always must be, with an advantage to the whole community. As the ores within reach were exhausted, and the impediments to following them presented themselves, with which you are all well acquainted, new acts and more enlarged means became requisite; the expense of trials with a view to discovery became much greater, and the profit that was likely to result was often determined by the œconomy used in every part of the process. Eighty years ago the mines of Cornwall were under the influence of such circumstances; few points were left unexplored that could be reached by the methods then known; and carried down, as many of them had been, below the level of the sea, a new power was required to extend them. This power was found in the extraordinary invention of the steam-engine; and we find accordingly, in the earliest period of the introduction of this machine, that the inventor looked to the Cornish mines as a promising field for their labour. In my opinion the introduction of the steam-engine produced a much wider range of advantage than resulted from the mere assistance it gave to the drainage: it introduced among miners a succession of highly gifted men; and we may reckon among such the names of Newcomen, Smeaton, Watt, Mardock and others, who, while their skill and judgement in mechanical pursuits improved many essential parts, contributed by their example to give a tone to the management of other things; experiment became fashionable, and was conducted with precision and discretion. The engines succeeded in draining the mines; but the expense which attended it, and the capitals which were required, imposed the necessity of œconomy in all branches of the business, and men's minds were sharpened to the observation of whatever might conduce to the end that was kept in view. A series of consequences followed, from which we at the present day reap the benefit; and mines in that district are now worked with advantage, which by the simplest calculation would be found to be unprofitable under former usages. The number of mines was sufficient in a moderate distance to keep up and encourage emulation; and their extension and greatly increasing depths stimulated the persons who conducted them to all the efforts within their reach. This emulation, whether it is in mining or in any other thing, is always most useful, almost I might say most necessary, to improvement. One miner builds a new engine,—his neighbour sees how it might have been done better; and at the next step a far better machine is produced. We learn from each other's failure, and from each other's

other's success: let us not wish to avoid this rivalry, but let us keep it within the bounds of manly and friendly competition, and it will be productive of nothing but good; and the advances which are made, be they by one or another, will have their natural tendency to the benefit of the whole.

Mining, then, in Cornwall became not so much a matter of chance as of systematized experience and careful management; still, however, attended by those uncertainties to which it is proverbially liable, which defy the greatest experience and baffle the soundest judgement in many instances.

It is no reproach to a country not to adopt new methods before they are wanted, as it is also wise to consider and follow them when circumstances render them applicable. Most have discovered certain practices suited to their own case, and it is absurd to undervalue or discard any thing for the sake of novelty; but we may safely take advantage of the experience of others, and no man's knowledge extends so far that he may not profit by inquiry and observation; and this is perhaps more especially true as to mining. What was commenced long ago has been much accelerated and systematized in the last 20 years; many abuses have been corrected, and public opinion has exerted its influence in this as well as in other things. The improvements that have thus been introduced may perhaps be divided into two classes, technical and moral: the first applying to the direction of the works and the apparatus by which they are assisted; and the other to the government of the agents and men by whom the operations are performed. Some account of the principal improvements of the last 20 years has lately been published in the transactions of the Royal Cornwall Geological Society, by my friend Mr. Joseph Carne, of Penzance; and I should have been glad if I could have referred to them in thinking of this short abstract of them. I should arrange, however, the technical improvement under the following heads:—1st, A systematic mode of conducting trials modified by experience of the circumstances, instead of chance efforts or irregular attempts. By this, expense is diminished, and a foresight is employed by which useless works are avoided; a smaller number of shafts require to be sunk, and the levels are made to lay open the ground, and leave it in the state most favourable to be worked away, and as free as possible from the interruptions from water and other impediments. 2nd, The fluctuating nature of the produce of mines has been attempted to be corrected by a judicious advance of the works of discovery, so as to precede those of exhaustion, or to govern the quantities of ore raised in some degree by the progress of discovery. By a prudence in this respect many mines have not only long been maintained in a profitable state, but it is most certain that many most valuable discoveries have been made, which otherwise would have been lost; and their success has attended the re-opening many old mines, that were reputed to be worked out, but had been abandoned for want of this discretion. No mine can be said to be in a safe state where there are no reserves, as fresh deposits of

of ore often require time and money to reach them. 3rd, The treatment of the ore in washing and dressing has been governed by those rules, derived from a more perfect knowledge of what may profitably be done, obtained by correct assays and comparisons of the value and the expense of acquiring it. 4th, The drainage of mines has been so much improved, that not only has the steam-engine removed the obstacles which prevented our pursuit of the ore, but the expense of this method has been reduced from a limit which only could be reached by the most productive, so that it is now within the compass of most. I found lately, upon calculating the expense of drawing the water by steam power in some of the deep mines of Cornwall, that with the saving in the quantity of coal in the last 20 years, coupled with the reduced price of the fuel, owing to better methods of purchase and conveyance, the amount is now but about 1-6th of what it formerly was. Steam-engines themselves are not only also less costly to erect, but they are more certain in their effect, and less liable to those hindrances which are so injurious to the miner.

In all the equipment of our engine shafts also there is a great alteration for the better. Pumps, rods and pitwork of all kinds are simplified and improved; and the consequence is, that both with water and steam power great expense is avoided by the wear and tear that was common in former times. Complicated attempts have been discarded, and difficulties are met with more judgement and experience than were formerly employed.

5th, Ventilation is provided for by a more just consideration of the circumstances required to produce it; and this seldom fails, or if it do in extraordinary cases, we have more ingenious contrivances to help us than we formerly had.

6th, The extraction of the waste and ores from below, and their transport on the surface, has been rendered more œconomical than formerly; which, however, applies in a much greater proportion in deep mines than in shallow ones. I have found, where the stuff is drawn 150 to 200 fathoms deep, that by the use of better shafts, of rail-roads under ground, and upon the surface, and other well organized arrangements, as much is saved in this way in proportion, as I observed in the expense of drainage by steam-engines.

7th, The labour of the workmen is better arranged, more space is allowed to a given number, they are placed so as to be freer from interruption from each other, or from other causes; and therefore their labour is more effectual and less expensive in proportion to what is done.

What I am inclined to call the moral improvements in mining, relate to the government of persons by whose agency they are carried on:—the great principle that is to be kept in view being the union of interests to one common end; to combine that of the employer with that of the employed; to enlist, as it were, the experience and ingenuity of all to conquer difficulties and to effect a common purpose. This proposition, though simple and as it were self-evident, is far from being easy of application; and men may easily

easily differ as to the mode of rendering it useful after they have admitted its propriety.

As the greatest expense of mining is in the payment of mere labour, so the greatest œconomy will be in rendering labour most effective with the least cost. Payment by contract for work done, and remuneration according to the quantity of ore obtained, or according to the measure of ground penetrated, were important steps in this part of the œconomy of mines, and are accordingly to be found in all districts; and formerly there was an inclination to rest upon these as if every thing desirable had been thus accomplished. But labour is cheap or dear according to the real quantity performed for a given amount of money; and where prices were adjusted only by a reference to what had been earned, the calculation was often deficient in one most important element:—the skill and industry of different men were not sufficiently taken into the account; and the system might be pursued with a kind of injustice, if I may so express it, confounding the industrious with the indolent, the strong with the weak, the skilful with the ignorant. To obtain a just appreciation of this difficult subject, a system of perfect supervision was found necessary; and in proportion to the importance of this part of the management of mines, have been the means of control employed to govern it. At first sight, the expense of the number of agents required for this vigilance has often been objected to, and it may need a thorough and intimate acquaintance with the subject to understand its utility. But when perfectly understood and judiciously enforced, its value will not, I think, be underrated; its object is not to depress the wages of the workmen to the lowest possible limit, but to secure to the employer the utmost reasonable quantity of labour for his money; and this will frequently be found to be more compatible with decent means of support, and terms that excite activity and exertion, than a more parsimonious system, by which industry is damped and physical strength is reduced. Among the improvements of modern times, therefore, I reckon the employment of a class of agents, selected for their character from among the class of working miners, practically versed in the work they have to direct, and interested in the success of the concerns they are engaged in, by the dependence which they will naturally feel upon it. Auxiliary to these ends, public competition for contracts has been introduced, destroying the partiality which occurs in private bargains, checking the judgement of agents by that of greater numbers of the men, and expediting the means of agreement. As the means of drainage became expensive, and as the cost of establishments became larger, and amounts of invested capital increased, so it became necessary that time should not be wasted, or left to the will and caprice of workmen; and rules were organized to control and regulate an orderly application of the labour, by which alone a due progress could be made. In the payment of labour, many salutary improvements have taken place; among the foremost of which, I should esteem that of its being made at regular and stated periods and in ready money. The system by which pro-

prietors or agents exact profits from the supply of necessaries to the workmen, is fortunately much exploded in most mining districts; and though it is continued and defended in some large establishments, yet I venture to think, the good effects of a contrary practice are well established, and admitted in most well conducted mines, and evinced by the lower rate of wages and greater comparative comfort of the labourer. Another improvement of our times may be esteemed the mode of purchase and supply of the various stores and materials which mines require. Formerly, agents were dealers in those articles, and their emolument was made more to depend on the quantity of goods they sold, than on their attention to the true interests of their employers. The very persons who ought to limit consumption were thus encouraged to promote it, and all useful check was destroyed. A great alteration has taken place in this respect; agents have gained much by it in character and respectability, though it is fair to admit that I believe it has been detrimental to their pockets. We may observe, however, a more careful attention to the purchase and the distribution of stores, an œconomy of first-rate importance to mines; and as the undivided attention of agents is directed to the success of the concerns from which they derive their subsistence, so their zeal is excited and their efforts are stimulated to promote it.—Among the modern improvements, I may add the mode in which the accounts are kept, showing, in many instances, a dissected and arranged statement of the application of the funds to the varied demands of the concern. Nothing has contributed to throw more light upon the subject, nothing has been more useful, by giving the means of coming to a just conclusion: and nothing is more dangerous than mining without clear and short accounts of expenditure. Many of the improvements I have alluded to are, or have for a long time been, common to many mining districts, and I by no means intend to describe them as confined to one in particular. They have been carried on, and matured by a collision, from different parts; some have originated in one place and some in another, and those who have desired to improve have benefited by the general experience. More general means of information diffused through the ranks of those we employ, have been turned to great account; and we see that practical information on many parts of geology, of mechanics, and hydrostatics, as well as geometry and figures, has contributed to assist in the better management of mining affairs. I can recollect when a rude section of a mine was a rare thing to be found, and at this time we rely upon them, in many instances, as guides in our operations. The steam-engine and the more complicated machine were understood formerly only by a select few; and now they owe some of their most important improvements to individuals whose attention has been called to their use in our mines.

If I were asked of what use are all these improvements in the management of mines, if their profits be not increased, I must reply, by inquiring, in what state mining in Great Britain would have been without them. Our rich shallow mines have mostly been exhausted, and

and our deep mines must have lain unwrought; and as we must have depended on foreigners for a supply of some of our metals, so our manufacture must have dwindled and passed to other countries. A valuable branch of national industry must have passed from us, and an industrious and hardy race of workmen must have turned their labour to other employment, or must have found a subsistence on other shores. We are struggling now, it is most true, with difficulties that threatened the existence of many most important undertakings; and I would ask, what is likely to carry us through these trying times, if it cannot be done by a well-arranged system of œconomy. I would ask, how many mines could exist under such circumstances, if it were not for the aid that this œconomy can give them. A more general diffusion of capital and skill may, it is true, have conduced to cause a greater production, and therefore for a time a depression of prices; but as the very depression must encourage demand, and will at the same time diminish supply, it may be fairly expected that the one will accommodate itself to the other, so as to leave a fair remuneration in the end, and this may, probably, be hastened, if a prudent limitation of produce were attended to, and which a just œconomy and well-arranged system may render practicable. I venture to think also, that some progress has been made in a more equitable adjustment of what may be called the rent of mines called royalty dues, duty, and so on, in different districts. Formerly, it was general to fix the same proportion for all mines, not distinguishing the circumstances under which mines yielded their produce. These circumstances differ indeed much more in some countries than others, and therefore greater uniformity may prevail in one than the other: but, as it is clear that rich land can pay a higher rent than poor land, or that difficulties of cultivation must be allowed for in rent, so it must be in mining. If the charge of drainage in a mine be equal to 1-6th of the value of the produce, it cannot pay the same rent as a dry mine; and especially if we consider the capital invested in the one case and the other. The proper adjustment must always be difficult where so much depends on chance. The lord has to consider what inducement should be held out to enterprize, and what profits are due to risk and investments of capital; and allowing these, he has a right to expect a fair and spirited exertion in working his land. The profits are to be divided in some proportion between lord and adventurers, and no one will contend that each should not have his due share; and unless that participation be allowed, mining must after a time cease.

In Cornwall, the dues vary much more than in other parts of the kingdom; while in Cumberland and the North they are more uniform: this may be attributed to the differing circumstances under which mining is carried on. In the one case, the metal is produced by the application and constant use of expensive means; in the other, the ores lie above the level of adit and in situations easy to explore.—The extreme fluctuation of prices makes the calculation of royalty more difficult; this is better provided for in other districts than in this, by the lords agreeing to take a certain part of the

the ores or of their value, by which his rent rises and falls with the prices. In Wales only, the practice exists of taking a fixed sum on the ton of ore, whatever its price may be; and it is easy to see how differently this must press, whether it has to be deducted from 18*l.* or from 9*l.* High prices too which are hardly likely to exist again, have induced a high rate of payment. I am persuaded that the lords will at some time find it to their advantage to consider this question, and particularly with a reference to the competition in the lead market by the Spanish miners, who pay but five per cent. upon their produce; while in parts of this country, the royalty absorbs from a fourth to a fifth of the gross value. One common interest will unite lords and adventurers to support establishments so important to themselves and to national industry: what is the interest of the one is really and truly that of the other; and I am persuaded, from the result of my experience, that when a different view has been taken of the subject, it has arisen from a want of enlarged and liberal understanding of the matter. If the improvements and principles to which I have alluded are important and valuable, allow me to express my opinion that this part of the principality offers a most promising field for their development and application. Though honoured in this enviable manner by your notice, I am comparatively but a stranger among you, and my knowledge of the district may be considered as but incomplete; but I have found my first impressions respecting it to be confirmed by further acquaintance. Many of the lead mines in other parts of Great Britain are much exhausted, and appear to afford few chances of much further discovery. Here you possess an immense tract of unexplored and promising ground to which the improved practice of mining is applicable. Other parts are burdened with heavy charges of land carriage;—your means are as it were at the doors of the first port of the world; they are placed in a fertile country, with cheap and abundant fuel and excellent roads, and you have an able and hardy race of men, who have shown themselves capable of every exertion that mining requires, and who will perceive in time, as many already do, that the discipline which at first seemed irksome, is intended for the common good; and that it must be the true interest of their employers to encourage industry and regularity of conduct, inasmuch as it is essential to the success of their undertakings. It is painful, with such hopes and prospects, to see them clouded and blighted by circumstances over which we have no control, and which we cannot appreciate so as to contemplate their progress and results; but a patient prudence and a well directed œconomy are powerful enough to overcome many difficulties. The causes of our present privations are probably complicated, and I will not attempt to enter upon them: but if our production be, as it probably is, one principal cause, sound discretion will point out to us not to press an overloaded market with an article to be disposed of at ruinous prices, which, being withheld for a time, may meet a ready and profitable sale; it will suggest to us not to exhaust our mines in periods of depression, so as to have the work of discovery

to

to perform when better times come. Many mines must probably be abandoned if prices do not soon improve; but in North Wales particularly, I think many valuable concerns may by prudence be supported through an adverse period. Such efforts are worthy our best exertions, and many that I see around me are well qualified to conduct or to encourage them. If there is any thing that I have done since I came among you, or any thing that I can do for the future, which may be thought conducive to so great a purpose; if humble efforts like mine can assist the public welfare, it is to me the highest gratification to reflect that my labours have been so appreciated, affording the strongest stimulus to future exertion. You have bound me by the firmest ties, you have distinguished me by an expression of your regard, far, I fear, beyond any merit that I can claim; you have associated my name with an advance in improvement which I am well conscious has been made principally by many other meritorious individuals, and in which my task has been little more than the pleasing one of approving and encouraging exertions well conceived and judiciously executed. Gentlemen, I will appropriate to myself all your kind friendship, your too partial regard; but you will allow me to think, that in this distinguished expression of your approbation you have chosen me to represent a system you approve and principles that are worthy your support. To be such a representative is sufficient honour for any man, as it supposes a desire in him to accomplish useful purposes by proper means; but while you most kindly have intended me this high token of your regard, you are lending your support to the means which you tell me I have been the humble instrument of introducing to your notice, and respecting which my most ardent wish is that they may prosper in your hands, and prove most beneficial to a neighbourhood to which I have so much cause to be attached. You have noticed with kind approbation the benefit of free communication from myself and agents in all matters interesting to our common pursuits. I am hardly conscious in this respect of having done much more than to express my wish to assist in any case where assistance might be useful. The difficulties of mining are so great, that they call frequently for sympathy and aid. I have during many years had them extended to me by masters in the art; it is to this friendly feeling that I owe very much of what I know upon the subject, and I have no regard for that ungenerous policy that would seek to profit by the failure of others. The profit of mining must be sought for in another direction; and it is one thing above all others that attaches me to the pursuit—that it is not exclusive, but the good that is attained is commonly shared by many. The district in which I have gathered most of my experience, is an example in this respect; and every new invention and every step in improvement is freely communicated and discussed, and the most important benefit has thereby accrued in this mutual interchange of knowledge—it has been habitual therefore to me to give as well as to receive. Cornwall is not singular in this respect; in every part of the Continent, and throughout all Germany where mining has been studied for so many years, and so many practices

tices are conducted with the greatest skill, my sons can testify that the mere name of an English miner every where called forth the kindest welcome, and every where opened the door to all kinds of information which they were in search of; I therefore cordially cherish the feeling that we ought not to be outdone in such generous sentiments.

I would fain, gentlemen, now communicate to you how I am impressed by the honours you have conferred on me this day; but in this I should fail if I ventured to enlarge upon it, and I must attempt but little, inadequate as any thing I could say would be to give a just picture of my feelings on this occasion. Arduous and almost overpowering as many of my duties have been, I have been cheered on by the kindness of friends, or by those who have reaped advantage from successful efforts;—how much more must I value this unlooked-for and spontaneous expression of approbation from those whose regard is so disinterested, whose favour I have had so few means of cultivating! Gentlemen, the impression you have made on my mind is too deep to vent itself in complimentary words; it will remain a theme of grateful recollection and a stimulus to exertion, and it will associate itself with all the best wishes for you and yours that you can desire or that I can offer.

THORITE, A NEW MINERAL, AND THORINA, A NEW EARTH.—BY M. BERZELIUS.

A new mineral substance, discovered near Brevig in Norway by M. Esmark, was sent to me for examination. It is compact and black, brittle and semi-hard; it has the vitreous fracture of gadolinite; when powdered it is of a dark brown colour; its sp. gr. is 4·8. Under the flame of the blowpipe it loses water, and becomes yellow. This mineral is a new earth, which has so many properties belonging to the substance formerly called thorina, that I thought at first the mineral actually contained it. This was not confirmed by experiment, but I have nevertheless retained the name of thorina. This mineral is constituted of

Thorina	57·91
Lime	2·58
Oxide of iron	3·40
——— manganese	2·39
Magnesia	0·36
Oxide of uranium	1·58
——— lead	0·80
——— tin	0·01
Silica	18·98
Water	9·50
Potash	0·14
Soda	0·09
Alumine	0·06
Insoluble stony matter	1·40
	99·20

Thorina

Thorina possesses the following properties: it is colourless and infusible, and when it has been heated to strong redness, it is insoluble in all acids except the sulphuric; it is not rendered soluble in other acids by calcination with an alkali. It is insoluble in caustic potash, but soluble when taken up by the carbonate, from which it is partially precipitable by heat, but redissolves in the cold. Its salts have a purely styptic taste. Sulphate of thorina, when the solution is strong, becomes a thick mass by boiling, but it is soluble in cold water; this property characterizes the new earth very particularly. Sulphate of potash, when the solution is saturated, produces a precipitate in it; this character belongs also to the salts of cerium; the precipitate is a double salt, soluble in pure water. Ferrocyanate of potash precipitates it as it does yttria.

Potassium does not reduce thorina, but the chloride of thorinium readily; this chloride may be obtained in the same manner as that of alumina. The reduction is accompanied with a feeble detonation. The product is a powdery, grey metallic mass, which dissolves very rapidly in muriatic acid, but very slowly in nitric and sulphuric acids. Neither water nor the alkalies act upon the metal. By rubbing it acquires a lustre; it burns in oxygen gas with a brilliancy which may be compared to that of phosphorus. The colourless earth is regenerated, and without undergoing fusion. Thorina contains 11·8 per cent of oxygen.—*Hensman's Repertoire,* June 1829.

COMPARATIVE ANALYSIS OF BONES.

Dr. Fernandez de Barros found in a thousand parts of

Sheep's Bones	Carbonate of lime	193
	Phosphate of lime	800
Hens' Bones	Carbonate of lime	104
	Phosphate of lime	836
Fishes' Bones	Carbonate of lime	53
	Phosphate of lime	919
Frogs' Bones	Carbonate of lime	24
	Phosphate of lime	952
Lions' Bones	Carbonate of lime	25
	Phosphate of lime	950

Jameson's Journal, October 1829.

ACTION OF ÆTHER ON SULPHATE OF INDIGO.

M. Cassola states that when sulphuric æther is added to sulphate of indigo, in about half an hour, at a temperature of about 30° Reaumur, the colour of the indigo totally disappears, and no substance whatever is capable of restoring it.

The colourless mixture being subjected to distillation, yielded a liquor which reddened litmus strongly, and gave no precipitate with barytic salts; but with a solution of nitrate of silver a precipitate was obtained, soluble in ammonia.—*Hensman's Repertoire,* April 1829.

COMBUSTIBILITY OF CARBON INCREASED BY PLATINA AND COPPER.

The following experiment is due to Wæhler:—Rasped cork is to be heated in close vessels with ammonio-muriate of platina, or verdigris, when a charcoal will be obtained, which, though it will not inflame spontaneously, does so if slightly heated, and then continues to burn of itself. The charcoal obtained from cork without these additions, does not inflame at so low a temperature, nor continue to burn in small masses, if once inflamed and left to itself.

This effect is analogous to that discovered by Dœbereiner, as belonging to platina; but as regards copper, a more curious one of the same nature is shown very easily by a common green wax taper. These tapers are coloured with verdigris, and when burnt, the copper of the verdigris is reduced for a time on the wick. If such a taper be lighted, and the flame then blown out, leaving the wick glowing, combustion of the wax will still proceed, slowly indeed, but for hours and days together, until the whole of the wax is burnt, or until the combustion has reached some part where it is extinguished by the contact of neighbouring bodies. This does not happen with white tapers, and hence they are safer for ordinary uses.—*Royal Institute Journal*, October 1829.

M. ORFILA ON MR. SMITHSON'S MODE OF DETECTING MERCURY.

In the Annals of Philosophy, vol. iv. p. 127, N.S., Mr. Smithson has proposed to detect very minute quantities of arsenic and mercury; he states that all the oxides and saline compounds of mercury laid in a drop of muriatic acid on gold with a bit of tin, quickly amalgamate the gold; and he asserts that quantities of mercury may be rendered evident in this way, which could not be so by any other means.

M. Orfila having occasion to examine a syrup supposed to contain mercury, attempted to discover it by Mr. Smithson's voltaic pile. At first he was inclined to suppose that mercury was detected by it, but having himself prepared some of the syrup into which no mercurial salt whatever was put, he found that when acidulated with a few drops of muriatic acid, the gold became white in twenty-four hours, and the fire acted upon it as if it had been covered with mercury.

On examination it was found that on putting the small pile into four ounces of water, acidulated with fifteen drops of muriatic acid, the gold became white in twenty-four hours even in some parts untouched by the tin. When heated the gold recovered its usual colour; when the gold and tin not in contact were placed in this mixture, the gold suffered no alteration. An ounce and a half of distilled water containing only twelve drops of a saturated solution of common salt, caused white spots upon the gold of the pile in twenty-four hours; these were proved to be tin. The gold and tin put not in contact into a mercurial solution do not act. When gold is whitened by tin it is readily removed by muriatic acid, but this is not the case when the change has been effected by mercury; but a more certain method, according to M. Orfila, consists in placing the piece of gold at the bottom

bottom of a small glass tube, after having rolled it up, that it may occupy less space. When heated the mercury is volatilized and condenses in the upper part of the tube, the end of which has been previously drawn out by the lamp. No such effect is produced if the whitening has been occasioned by tin.

M. Orfila concludes, from the above and some other experiments, that the small apparatus invented by Mr. Smithson cannot be depended upon for the detection of small quantities of mercury, unless metallic mercury be separated from the gold by distillation, as above mentioned; because solutions which contain no mercury, but merely a little acid or common salt, produce appearances similar to those effected by mercury. M. Orfila nevertheless admits that the apparatus may be advantageously used, and will detect very minute quantities of mercury, by first treating the whitened gold with muriatic acid and then subjecting it to distillation.

ON PHOSPHORIC ACID.—BY M. GAY-LUSSAC.

M. Englehart has observed that phosphoric acid recently fused and dissolved in water precipitates albumen; a property which it did not previously possess, and which it loses after having been kept for some time in solution. Lately Mr. Clark has discovered that phosphate of soda exposed to a red heat, acquired new properties. It becomes less soluble, contains less water of crystallization, changes in form, and precipitates nitrate of silver white, whilst before calcination it precipitates it yellow.

These two observations by M. Englehart and Mr. Clark appear to possess some analogy; I have made some experiments to verify my suspicions.

I took some liquid phosphoric acid which had been during a long time in my laboratory, and having ascertained that it did not precipitate albumen, I saturated a part of it with carbonate of soda; the phosphate which I obtained precipitated nitrate of silver of a yellow colour.

Another portion of the same acid, calcined, and then saturated with soda, precipitated nitrate of silver white. Lastly, calcined phosphate of soda was decomposed by acetate of lead, and the phosphate of lead obtained was decomposed by sulphuretted hydrogen. The phosphoric acid separated precipitated albumen, and combined with soda it precipitated nitrate of silver white.

It results from these observations, that the remarkable change of properties, observed by Mr. Clark in the calcined phosphate of soda, is derived from the same cause which produces the same effect with phosphoric acid in similar circumstances. What proves it still further is, that phosphate of soda and phosphate of ammonia, made with calcined phosphoric acid, precipitate nitrate of silver white, and that common phosphate of potash acquires the same property by calcination. It is remarkable that the modification which phosphoric acid undergoes by heat is much more permanent when it is combined with a base, than when simply dissolved in water. Mr. Clark's opinion of the cause of these phænomena appears to require some modification.

LIST OF NEW PATENTS.

To J. Hutchinson, Liverpool, merchant, for improvements in machinery for spinning cotton, silk, linen, woollen, and other fibrous substances.—Dated the 30th of July 1829.—6 months allowed to enrol specification.

To J. Bates, of Bishopsgate-street Within, merchant, for his new process or method of whitening sugar.—1st of August.—6 months.

To N. Jocelyn, London, late of North America, artist, for improvements in the preparation or manufacture of blank forms for bankers' checks, bills of exchange, promissory notes, post bills, and other similar instruments, or securities for the exchange of payments of moneys, by which forgeries and alterations in the same are prevented or detected.—3d of August.—4 months.

To T. Bailey, Leicester, frame-smith, for improvements in machinery for making lace.—5th of August.—6 months.

To T. Brown, Birmingham, coach-maker, for his improved coach, particularly adapted for public conveyance and luggage.—5th of August.—6 months.

To W. Shand, esquire, Burn, Kincardineshire, for improvements in distillation and evaporation.—10th of August.—6 months.

To J. MacLeod, esquire, Westminster, surgeon on the Madras establishment, for improvements in preparing or manufacturing certain substances so as to produce barilla.—10th of August.—2 months.

To J. Rowland, Heneage-street, Brook-lane, Spitalfields, and C. M'Millan, of the same place, engineers and millwrights, for their improved process or mode of constructing, forming, or making street-ways, carriage-roads, and high-ways in general.—11th of August.—6 months.

To T. H. Rolfe, Cheapside, musical instrument maker, for improvements upon the self-acting piano-forte.—11th of August.—6 months.

To E. Weeks, King's-road, Chelsea, horticultural builder, for improvements in raising, lowering, or conveying heated water, or other fluids, to various distances.—14th of August.—6 months.

To H. C. Price, and C. F. Price, Bristol, ironmongers, for their improvements in and upon certain apparatus, already known for the communicating of heat, by means of the circulation of fluid.—20th of August.—6 months.

To J. Musket, York-square, Regent's-park, gentleman, for a certain medicine, found of essential and peculiar benefit in gouty affections of the stomach, spasms, cramps, inflammation of the lungs, violent and confirmed coughs, pains after child-birth, and in other pains in the breast and bowels, beyond any other medicine or application in like cases.—20th of August.—2 months.

To J. Jones, Leeds, brush-maker, for improvements in machinery or apparatus for dressing and finishing woollen cloths.—21st of August.—6 months.

To W. Roger, Norfolk-street, Strand, lieutenant in the royal navy, for improvements in the construction of anchors.—21st of August.—6 months.

To

To G. H. Manton, Dover-street, Piccadilly, gun-maker, for an improvement in the construction of locks for all kinds of fowling-pieces and fire-arms.—2d of September.—2 months.

To J. Tucker, Hammersmith, Middlesex, brewer, for improvements in the construction of cannon.—9th of September —6 months.

To T. S. Brandreth, Liverpool, barrister-at-law, for a new method of applying animal power to machinery.—9th of September.—6 mon.

To J. A. Fonzi, Upper Marylebone street, Middlesex, esquire, for improvements on fire-places.—9th of September.—6 months.

To J. Soames, jun., of Wheeler-street, Spitalfields, soap-maker, for a new preparation or manufacture of a certain material produced from a vegetable substance, and the application thereof to the purposes of applying light and other uses.—9th of September.—6 mon.

METEOROLOGICAL OBSERVATIONS FOR SEPTEMBER 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·28. Sept. 26. Wind S.—Min. 29·24 Sept. 18. Wind S.W.
Range of the mercury 1·04.
Mean barometrical pressure for the month .... 29·821
Spaces described by the rising and falling of the mercury........... 7·710
Greatest variation in 24 hours 0·660.—Number of changes 28.
Therm. Max. 69° Sept. 10. Wind S.E.—Min. 39° Sept. 29. Wind N.W.
Range 30°.—Mean temp. of exter. air 55°·87. For 31 days with ☉ in ♍ 57·45
Max. var. in 24 hours 19°·00—Mean temp. of spring-water at 8 A.M. 54·96

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere in the morning of the 10th... 97°
Greatest dryness of the atmosphere in the afternoon of the 4th... 52
Range of the index 45
Mean at 2 P.M. 61°·8.—Mean at 8 A.M. 73°·8.—Mean at 8 P.M. 78·8
—— of three observations each day at 8, 2, and 8 o'clock .... 71·5
Evaporation for the month 1·70 inch.
Rain in the pluviameter near the ground 4·59 inch.

Summary of the Weather.

A clear sky, 4; fine, with various modifications of clouds, 14; an overcast sky without rain, 4; rain, 8.—Total 30 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
25	10	28	0	25	22	21

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
5½	2½	0	1	3	8½	6½	3	30

General Observations.—This month has been generally wet, windy, and unusually cold for the beginning of autumn. From the 4th to the 20th it rained more or less every day, and was often accompanied by strong gales of wind. The second crops of grass about this neighbourhood, which are greater in quantity in many places than the first, have been much injured on the ground by the continually wet weather.

In the evening of the 7th a thunder-storm passed over, and was followed by heavy showers from passing *nimbi*, in one of which a lunar iris appeared in

in the N.E. quarter from 9 hours 48 minutes till 10 hours P.M. It exhibited a bright, but almost colourless arc of a great circle; and when in the densest part of the *nimbus* it reflected a bow above, about the same parallel distance as the exterior is seen from the interior solar rainbow. This phænomenon very rarely happens, and it is the first time that we have observed an exterior lunar iris, which from the age of the moon, only 9½ days, was naturally faint by reflection. The apparent width of the interior iris at its brightest appearance was two degrees, and its diameter on the horizon 72 degrees, which corresponded nearly with the measurement of a solar rainbow between 6 and 7 o'clock the preceding morning.

In the afternoon and evening of the 14th, heavy hail-showers fell here, accompanied with lightning and thunder. A large lunar halo in the evening of the 15th, and solar halos in the mornings of the 16th and 17th, were succeeded by heavy rain and strong gales.

The last five or six nights the hoar frost was prevalent, and thick in the grass fields early in the mornings. This is certainly an early beginning of wintery weather.

The mean temperature of the external air this month is remarkably low, being four degrees under the mean of September for the last fourteen years, and four-fifths of a degree under the coldest September during that period. The temperature of spring water arrived at its maximum for the year on the 7th.

The atmospheric and meteoric phænomena that have come within our observations this month, are, one lunar and five solar halos, three meteors, four rainbows, and one double lunar iris, lightning on four days, and thunder on two; and ten gales of wind, or days on which they have prevailed; namely, one from the North-east, two from the South-east, one from the South, five from the South-west, and one from the West.

REMARKS.

London.—September 1, 2. Cloudy. 3, 4. Very fine. 5. Cloudy. 6. Fine, with slight showers. 7. Fine: rain at night. 8. Fine morning: heavy rain in the afternoon. 9. Very fine: rain at night. 10. Wet morning: stormy, with showers: strong gale at night. 11. Fine morning: stormy and wet, with strong gale at night. 12. Cloudy: with some thunder and rain at 3 P.M. 13. Fine morning: cloudy. 14. Fine. 15. Fine morning: cloudy, with heavy thunder-storm at 4 P.M. and much rain. 16. Wet morning: stormy. 17. Cloudy: heavy rain at night. 18. Foggy, with slight showers. 19. Wet morning: fine. 20. Fine: rain at night. 21—25. Very fine, with slight fogs in the morning, and at night. 26. Very fine: drizzly at night. 27. Drizzly: cloudy. 28. Fine morning: cloudy. 29, 30. Foggy in the mornings: very fine.

Penzance.—September 1—4. Fair. 5. Fair: showers. 6. Fair. 7. Clear: showers. 8. Showers, hail, and rain. 9. Fair. 10. Rain. 11. Fair: rain. 12. Fair: showers. 13. Rain. 14. Fair. 15. Fair: rain. 16. Rain. 17. Fair: rain. 18. Rain. 19. Fair. 20. Clear: rain. 21. Clear. 22. Fair. 23. Rain at night. 24. Clear. 25. Fair. 26. Rain. 27. Fair: showers. 28. Showers. 29. Clear: showers. 30. Clear.

Boston.—September 1. Cloudy. 2—4. Fine. 5, 6. Cloudy. 7. Fine: rain at night. 8. Rain. 9. Fine. 10. Rain. 11. Cloudy: rain early A.M. and P.M. 12. Fine. 13. Fine: rain at night. 14. Cloudy: rain P.M. 15. Fine. 16. Cloudy. 17. Fine: rain early A.M. 18. Cloudy. 19. Rain. 20. Fine. 21. Fine: rain early A.M. 22—24. Rain. 25. Fine. 26. Cloudy. 27. Rain: beautiful rainbow quarter past six A.M. 28. Fine. 29. Fine: rain P.M. 30. Fine.

Meteoro-

Calendar of the Meetings of the Scientific Bodies of London for 1829–30.

Societies.	Time of Meeting.	November.	December.	January.	February.	March.	April.	May.	June.
Royal . . . . Somerset-House.	Thursday, 8½ P.M.	19, 26, 30*	10, 17, 24	14, 21, 28	4, 11, 18, 25	4, 11, 18, 25	1, 22, 29	6, 13, 20, 27	10, 17
Antiquaries . Somerset-House.	Thursday, 8 P.M.	19, 26	3, 10, 17, 24	14, 21, 28	4, 11, 18, 25	4, 11, 18, 25	1, 23*, 29	6, 13, 20, 27	10, 17
Linnean . . . Soho-Square.	Tuesday, 8 P.M.	3, 17	1, 15	19	2, 16	2, 16	6, 20	4, 24*	1, 15
Zoolog. Club Soho-Square.	Tuesday, 8 P.M.	9, 23, 29*	14	12, 26	9, 23	9, 23	13, 27	11, 25	8, 22 July 13, 27
Horticultural Regent-Street.	Tuesday, 1 P.M.	3, 17	1, 15	5, 19	2, 16	2, 16	6, 20	1*, 4, 18	1, 15
Society of Arts Adelphi.	Wednesd. 7½ P.M.	4, 11, 18, 25	2, 9, 16, 23	13, 20, 27	3, 10, 17, 24	3, 10, 17, 24, 31	7, 14, 21, 28	5, 12, 19, 26	2, 9
Royal Society of Literature Parliament-St.	Wednesd. 3 P.M.	4, 18	2, 16	6, 20	3, 17	3, 17	7, 21, 29*	5, 19	2, 16
Zoological Society... Bruton-Street.	Thursday, 1 P.M.	5	3	7	4	4	1, 29*	6	3
Geological . . Somerset-House.	Friday, 8½ P.M.	6, 20	4, 18	1, 15	5, 19*	5, 19	2, 16	7, 21	4, 18
Astronomical Lincoln's-Inn Fds.	Friday, 8 P.M.	13	11	8	12*	12	Wednesd. 7	14	11
Royal Institut. Albemarle-St.	Friday, 8½ P.M.	...	...	22, 29	5, 12, 19, 26	5, 12, 19, 26	2, 23, 30	7, 14, 21, 28	4, 11
Royal Asiatic Grafton-Street.	Saturday, 2 P.M.	...	5, 19	2, 16	6, 20	6, 20	3, 17	1, 15	7*, 19 July 3, 17

* Anniversaries.—Royal, Nov. 30, 11 A.M.—Antiquaries, April 23, 2 P.M.—Linnean, May 24, 1 P.M.—Zoological Club, Nov. 29.—Horticultural May 1.—Royal Society of Literature, April 29.—Zoological Society, April 29, 1 P.M.—Geological, Feb. 19, 1 P.M.—Astronomical, Feb. 12, 3 P.M.—Royal Institution, May 1.—Asiatic, June 7, 1 P.M.

[Copies of the Calendar on Cards may be had at the Office of the Philosophical Magazine and Annals, Red Lion Court, Fleet Street.]

Meteorological Observations made by Mr. BOOTH *at the Garden of the Horticultural Society at Chiswick, near London; by Mr.* GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1829.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.									
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
Sept. 1	29·998	29·950	30·05	30·03	30·04	30·01	29·43	65	55	67	55	66	56	58·5	NE.	NE.	N.	E.	...	...	...	0·060	...
2	30·076	29·938	30·00	30·00	30·11	30·00	29·32	67	48	62	55	67	48	60	N.	N.	N.	N.	...	...	...	...	...
3	30·170	30·126	30·12	30·10	30·22	30·18	29·60	68	49	60	50	66	48	51·5	SW.	N.	NE.	NW.	0·20	...	...	...	...
4	30·026	29·909	30·05	30·00	30·10	30·02	29·42	67	47	63	50	63	52	55·5	S.	SE.	W.	NW.	...	...	...	...	...
5	29·693	29·444	29·60	29·55	29·77	29·54	29·08	65	51	64	54	65	54	57	S.	SW.	S.	NW.	...	0·05	0·060	·150	...
☽ 6	29·533	29·502	29·45	29·45	29·60	29·57	28·85	67	45	63	53	67	51	60	SW.	SW.	SW.	W.	·25	·08	...	·210	...
7	29·654	29·518	29·50	29·50	29·71	29·61	29·07	67	49	62	52	65	53	55	S.	SW.	S.	NW.	...	·12	·330	·705	...
8	29·576	29·483	29·55	29·50	29·67	29·65	28·81	69	51	60	53	65	53	56·5	S.	W.	SW.	W.	...	·65	·300	·045	0·37
9	29·723	29·533	29·60	29·55	29·75	29·52	29·03	67	57	64	49	65	58	57·5	SE.	SW.	SW.	W.	·20	·47	·200	·350	...
10	29·384	29·222	29·35	29·10	29·42	29·27	28·85	70	52	61	54	69	52	61	S.	N.	SE.	calm	...	·10	1·060	·020	·45
11	29·685	29·424	29·75	29·60	29·78	29·56	28·90	66	48	60	52	63	48	53·5	NW.	W.	SW.	W.	...	·46	0·220	·350	·43
12	29·661	29·619	29·70	29·65	29·71	29·70	29·04	66	42	61	53	66	48	55	W.	W.	W.	W.	·20	·06	·240	·020	·16
○ 13	29·558	29·289	29·50	29·40	29·64	29·38	29·00	66	47	58	49	64	49	53	S.	SW.	S.	W.	...	·03	·705	·270	...
14	29·489	29·225	29·50	29·35	29·55	29·28	28·67	65	40	57	49	61	45	50	SW.	NW.	W.	NW.	...	...	·160	·035	·12
15	29·86[illegible]	29·675	29·75	29·70	29·90	29·74	29·10	64	44	60	49	62	51	52·5	NW.	SW.	W.	NW.	·10	·63	·4[illegible]5	·780	·03
16	29·661	29·534	29·60	29·50	29·65	29·56	29·15	56	40	62	53	64	45	52	NE.	SW.	NW.	E.	...	·14	1·060	·185	...
17	29·875	29·597	29·80	29·40	29·90	29·68	29·33	62	52	58	49	62	53	50	E.	SE.	SW.	calm	...	·55	0·315	·720	...
18	29·282	29·151	29·40	29·18	29·31	29·24	28·77	63	49	59	53	62	52	53	NW.	NW.	SW.	E.	·10	·02	·370	·110	·20
19	29·825	29·459	29·70	29·60	29·84	29·56	29·00	60	43	57	51	58	43	53	NW.	NW.	SW.	E.	·10	·02	·370	·110	·20
☾ 20	29·924	29·853	29·95	29·80	30·00	29·91	29·40	67	50	58	47	59	51	54	N.	[illegible]	N.	NE.	...	·09	...	·020	·49
21	29·953	29·760	29·80	29·80	29·93	29·80	29·16	68	38	60	52	63	46	51·5	NW.	NW.	W.	calm	...	·17	·440	·150	...
22	29·875	29·817	29·80	29·78	29·94	29·90	29·25	66	45	59	49	63	51	55	W.	NW.	NW.	W.	·15	...	...	...	·19
23	29·900	29·839	29·78	29·78	29·94	29·87	29·27	68	45	58	49	64	47	53	SW.	NW.	SW.	W.	...	...	...	·075	...
24	30·053	29·970	29·92	29·90	30·08	29·99	29·42	65	40	57	48	62	43	53·5	NE.	NW.	NW.	W.	...	...	·120	...	...
25	30·169	30·124	30·05	30·05	30·25	30·16	29·63	62	37	59	46	61	44	50	NE.	NW.	N.	NW.	·15	...	...	...	...
26	30·244	30·189	30·05	30·00	30·28	30·19	29·64	65	56	61	53	62	57	46·5	NE.	SW.	W.	NW.	...	...	...	...	·18
27	29·866	29·849	29·90	29·90	29·97	29·89	29·22	66	42	58	53	61	46	50	SW.	SW.	SW.	W.	...	·04	·180	·040	...
● 28	29·924	29·875	29·92	29·92	29·97	29·96	29·30	61	35	55	49	57	39	59	W.	W.	SW.	W.	·15	·05	·205	·170	·08
29	30·194	30·005	30·00	29·98	30·10	30·01	29·46	59	34	54	45	55	42	50	W.	NW.	NW.	W.	...	...	·170	·125	...
30	30·257	30·136	30·10	30·10	30·27	30·22	29·65	60	39	56	43	56	42	47	NW.	NE.	N.	NW.	...	...	·220	...	...
														50	N.	E.	NE.	calm	·20	...	...	...	·28
Aver.:	30·257	29·151	30·12	29·10	30·28	29·24	29·19	70	34	67	43	69	39	53·7					1·70	3·71	6·820	4·590	2·98

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

DECEMBER 1829.

LXII. *On the Plans, Arrangements and Methods, proposed and used by* Mr. F. R. Hassler, *with a view to an accurate Survey of the Coast of the United States. By the Chevalier* F. W. Bessel, *Professor in the University of Königsberg**.

IN 1807, Mr. Hassler, then in Philadelphia, was requested, on the part of the Government of the United States, to furnish a plan for the survey of the whole coast of that country. This was done in a letter to Mr. Gallatin, which proves great insight into the nature of such operations. It is evident from it, that the survey was to have been a work of great extent, and such as should satisfy the requisites both of geography and of navigation.

In consequence of this plan, Mr. Hassler went to England to procure the necessary instruments, &c. A most complete apparatus was brought together, consisting principally, of instruments constructed upon Mr. Hassler's own ideas; and in the year 1816 the operation itself began. It appears to have been interrupted soon after, and therefore not to have given the expected results †.

* This paper is a translation from Professor Schumacher's *Astronomische Nachrichten*, No. 137, by Professor Renwick of Columbia College, New York, and is extracted from Silliman's Journal. The *Notes* are those of the translator.

† The suspension of the operations for the survey of the coast of the United States, begun in so admirable a manner by Mr. Hassler, may be considered as a national misfortune. It is such in truth, not so much from the loss of the previous expenditures, in consequence of the delay, or from the deferring of its advantages to a future period, as from the fact, that the principles and methods proposed, and some of them actually used by Mr. Hassler, were in advance of the science of Europe at the period. As these principles and methods require the highest proficiency in mathematical and physical science, their application to practice originally in the United States would have redounded to the national honour.

 But

But Mr. Hassler describes his arrangements and methods in a paper which has also been printed, as an extract from the Philosophical Transactions of Philadelphia, which contains so many new views in relation to instruments, that I believe I shall make an agreeable communication to the readers of this journal by an extract from this paper, which has probably not become very extensively known (in Germany)*. Mr. Hassler appears by it as a man who would rather think for himself than imitate others, and whose arrangements, therefore, always bear an independent character.

It is to be lamented that circumstances should have occurred which hindered the complete execution of the work. To judge from the contents of the publication, not only complete success in reaching the intended object would have been obtained, but also many other useful results †.

According to Mr. Hassler's plan, two observatories were to be established, one in Washington, and one in New Orleans ‡: these were calculated not only for the purposes of the survey, but also to subserve the general objects of astronomy. Of the observatory for Washington, the whole plan is given, which appears to me very appropriate; it recommends itself by a minute attention to all that can secure the accuracy of the observations; we miss in it none of those arrangements which on this side of the Atlantic have been made in the most modern observatories; in its special arrangements this observatory often agrees with the most modern one in Germany, that of Altona §. The instruments are, a *transit*, of five feet, by

* [And we may say *in England* also: as we believe not more than two or three copies of that paper ever reached this country.—Edit. Phil. Mag.]

† The opinion thus expressed by Mr. Bessel, is praise of the highest description; for no man has ever stood higher as an astronomer than that distinguished Professor.

‡ According to Mr. Hassler's original plan, one of the observatories was to have been established in the State of Maine, near the north-eastern frontier, the other in Louisiana near the south-western boundary of the United States. Circumstances led to the choice of Washington for one; the exact place of the other, although it must have been near New Orleans, was not decided.

§ The close coincidence between the plan proposed by Mr. Hassler, for the observatory at Washington, and that erected under the superintendence of Schumacher at Altona, is very remarkable. This last is unquestionably the best in Europe, as well as the most modern. Mr. Hassler's plans were presented to our Government in 1816, but his papers were not published until 1826. The observatory at Altona was finished in the last-named year. Thus it appears that these two astronomers deduced from obvious principles two plans of the closest similitude, each without any knowledge of the other's proceedings, while the American project is prior in point of date by several years.—[A drawing of the plan of Schumacher's observatory is in the possession of the Astronomical Society of London.—Edit. Phil. Mag.]

Troughton;

Troughton; a *clock* by Hardy; and an eighteen-inch *repeating circle;* there were also to be placed in it, finally, a *zenith sector* and a *meridian* (mural) *circle*, &c. I cannot describe the building in detail, but I will remark that it was to be surrounded by a ditch, in order the better to avoid the oscillations of the ground, by the passage of waggons, &c. The pillars of the instruments were to be placed upon solid bases six feet thick, standing in a cellar of five feet depth, and to pass through the floor of the observatory, which was to be supported independent of them. The axis of the transit is thirty-three inches long, which also corresponds to the views of Reichenbach, who considers long axes as not advantageous; the cylindrical parts are of bell-metal, as usual with the English artists. The supports are not between the pillars, but upon them; a strong metal plate is fixed upon the middle of the pillar, bearing the parts which move the Ys, and these are moved in the direction of the meridian by screws, by which the adjustment to that direction is made; the usual vertical screw is not in the arrangement; instead of this, the piece bearing the Ys is formed like an arch, the middle of which is supported by a screw, the higher or lower position of which elevates or depresses it by the different degree of tension of the metal which is produced by the action of the screw and its own elasticity. This method promises to secure complete stability: but it is supposed that the two pillars have the same altitude, and also that no remarkable change should take place in them. The counterpoising apparatus is placed about five inches from the end, and consists of springs, which press rollers under the axis, performing what Reichenbach effects by levers and weights. By Mr. Hassler's arrangement, this counterpoising apparatus occupies the place on the pillars, which the supports formerly did; this arrangement, likewise, appears to me good: whether it would be applicable to very heavy instruments, remains still to be tried*. The two conical axes are not joined by a cube in the centre, but by a zone of a sphere of eight inches diameter, to which the two parts of the telescope tube are screwed; this arrangement is made with a view to greater stability.

Of the other instruments of Mr. Hassler it will not be possible to give an adequate description without drawings, but I may however indicate some of their peculiarities. The theo-

* The transit of the observatory at Greenwich is adjusted in this manner; and as it is ten feet in length, the doubt whether the plan be applicable to large instruments is settled by actual experience.—[The transit instrument at Greenwich is *not* counterpoised.—Edit. Phil. Mag.]

 dolite

dolite of two feet, not constructed for repetition, appears to me to possess a peculiarly good construction. From a hexagonal centre-piece emanate six horizontal conical arms, whose bases are three inches, and ends one inch and a half in diameter. Upon these arms the two-feet horizontal circle is made fast; three of these cones are longer; these contain at their ends the screw-work for the stands by which the instrument rests upon three vertical cones of brass, fastened to the wooden stand of the instrument; between this and the six horizontal conical arms there is room for the verification telescope, which has precisely the arrangement of a transit, and hangs in its Ys, which are fastened underneath to two opposite radii. This telescope has no lateral motion, but the wires in the focus are directed by means of a screw, to the object which is taken as the point of comparison during an observation. In the same hexagonal centre-piece is fastened the vertical axis, eleven inches long, and two inches in diameter. Upon this revolves a drum nine inches in diameter, and five inches and a half high; upon the upper surface of this, stand two columns bearing the Ys for the transit telescope by which the observations are made; this is a complete transit, and the columns are sufficiently elevated to allow its passage through the zenith. The horizontal angles are measured by the revolution of this upper part of the instrument upon the vertical axis, and are read off by three microscopes, which are fixed at the end of as many conical arms, coming from the central drum, each having a micrometer screw. The illumination is made through the axis of the telescope, the one side of which is perforated, the other has an altitude circle of six inches diameter. The axis is about twelve inches long, which is more than the interval between the columns. Its supports are therefore set upon pieces of brass, elevated above the columns, and extending outwards; they have the same kind of vertical adjustment as the large transit described above.

In relation to the observations with this instrument, Mr. Hassler properly remarks: that the eccentricity is equally corrected by means of three equidistant readings, as by two, four, or so on; he also shows that when the vertical axis is not perpendicular to the plane of the horizontal circle, the errors of the angle will be corrected if the position of the instrument's place is alternately changed to the three truncated cones of the stand, so as to give the three regularly succeeding positions of a full revolution. These three observations, each made in the two diametrically opposite positions of the telescope, and by a half revolution of the instrument, give a mean which is

free

free from eccentricity, from any error arising from the inclination of the circle towards the axis, or from any inequality in the supports of the axis, the readings being besides made upon twelve different parts of the division. This two-feet theodolite is very properly considered as the main instrument for the survey. For the other observations, repeating circles of eighteen inches, repeating theodolites of twelve inches, and repeating reflecting circles of ten inches diameter, smaller theodolites, needles, plane-tables, &c. are provided. To the most of these instruments Mr. Hassler has given a peculiar construction, but it would be too long, and perhaps without figures not sufficiently intelligible, to give a description of them here.

As signals Mr. Hassler employed truncated cones of block-tin, about nineteen inches high, seventeen inches diameter at bottom and fourteen at top; these were erected upon poles eight feet high, and rendered the best services. At a distance of about forty (English) miles they appeared as a luminous point, when the sun stood so that the rays of it were reflected towards the observer, which lasted during a sufficient length of time. At shorter distances the light was so strong, that a dark glass was often required for the observation. Here the same principle is made use of which in Mr. Gauss's heliotrope produces such a decided effect; but the advantages of the different arrangements are very unequal, because the cones of Mr. Hassler do not constantly reflect an image of the sun to the observer, while the heliotrope is constantly kept in the proper position to produce this effect. If the angle of the cone is represented by $2\,m$, then the cosine of half the azimuthal angle, when light shall be reflected to the observer, must be equal to the sine of half the sun's altitude divided by the sine of m. This would take place only during a moment if the sun had no diameter, and generally speaking, one signal would be invisible, when the other is visible; but as m is only a small angle, in the cones used by Mr. Hassler it is only $4^\circ\ 38'$, and as from the altitude of the sun, on account of the magnitude of its disk, two limits may be assumed which are at $32'$ distance from each other, the azimuthal distance corresponding to the altitudes of the sun, which admit of a reflection to the observer in a direction nearly horizontal, has a considerable magnitude within these limits. Yet it can have rarely happened, that both the signals needed for the measurement of an angle, could have shown at the same time an equally well reflected image of the sun; it seems therefore that the use of these signals might rather be recommended in particular cases than generally. However, Mr. Hassler says, that even with-

out

out the direct light of the sun, they also rendered good service, and were visible at great distances*.

Mr. Hassler has also communicated his methods for the comparison of the standard measures of length, and the results of their application; we gain by this a new comparison of the French and English measures, which I shall quote more in particular. There were three meters present. One of iron, which was one of those made by the committee of weights and measures in Paris 1799, and distributed as authentic among the foreign deputies; the two others, the one brass, the other iron, were Lenoir's, but not compared directly with the original, they therefore were not considered as principal in the results of comparison. These meters were compared with a scale of Troughton, of eighty-two inches in length, divided upon silver to tenths of inches, to which is added a micrometric apparatus to take off measures from the scale. Instead of the usual method in comparing a meter *à bouts* with one *à traits*, to place butting pieces with lines drawn near to the end of them, the distances of which are measured by the microscopes when these pieces are laid together, Mr. Hassler employed the end planes themselves; for that purpose he constructed the butting pieces exactly of the same thickness as the meters, and obtained, by the close juxtaposition of both, a line, which presented itself like a division line of the scale. By means of several experiments (reduced to 32° Fahr. and adopting the expansion of the iron and the brass, as Mr. Hassler determined it by his own experiments, namely between the point of melting ice and the boiling heat of water;)

$$\begin{cases} \text{iron} = 0{\cdot}0012534363 \\ \text{brass} = 0{\cdot}0018916254 \end{cases}$$

* To use the heliotrope, two conditions are indispensable; the attendance of an assistant at each signal station to direct it to the observer, and its actual illumination by the rays of the sun. Had Mr. Hassler's operation been intended to include no more than a net-work of great triangles, the heliotrope might perhaps have been used, as no more than two signals need have been observed from each station, and two assistants would have sufficed for their management. But the survey being necessarily conducted with a view to its immediate application to geographical and hydrographical purposes, it would have been necessary to multiply the signals to such an extent as to have rendered it impossible to employ so many separate attendants. Mr. Hassler's signals also answer well even in a cloudy state of the atmosphere, if the other circumstances be favourable, as frequently happens. The objection that two signals could rarely have shown an equally well-defined image of the sun does not hold good, when a fixed instrument observing without repetition is employed. We cannot therefore but think, that for all general purposes the signals of Mr. Hassler are preferable to the heliotrope of Gauss.

the length of the meter was determined to be 39·381022708 inches of the scale, which, as the standard temperature of the English measure is 62° Fahr., gives the length of the meter in English inches

$$=\frac{39 \cdot 381022708}{1 \cdot 0003152709} = 39 \cdot 36861 \text{ English inches.}$$

The two other copies of meters give less (0·001 inch); but these were compared both with the scale of Troughton in America and that which this artist himself uses in London, and had upon both very nearly the same length; whence it may be concluded, that both English scales agreed very nearly. Thus according to Mr. Hassler's comparison the meter is 39·36861 English inches: according to the comparison of two other copies by Kater = 39·37079. According to vol. iii. of *Base du Système Metrique*, page 469, the meter of platinum was = 39·382755; that of iron = 39·382649: both measured upon the brass scale of Mr. Pictet, reduced to the temperature of melting ice; at a mean = 39·3827, which, according to Borda's expansion for brass (0·001783, by which the experiments made in Paris were reduced to the point of melting ice, from a temperature = 12°·75 Centigrade, at which they were made) gives 39·37100." The two last comparisons agree very nearly, and their difference lies entirely within the limits of the uncertainty of thermometrical influence. The authentic meter of Mr. Hassler appears, however, really to be shorter, though it could be brought nearer to the others, by adopting other proportions for the expansion of metals*. This, however, appears not to be allowable, when the results of different comparisons are to be collected; for the determination of the expansion is as important as the comparison itself; therefore, each observer must remain answerable for that one which he adopts. I think it should be inquired whether two metals of the same chemical composition have the same proportion of expansion; or if a small chemical difference may not have a remarkable influence upon it; this investigation is more easy than that of the absolute expansion itself. It can be known only after a previous experiment of this kind, whether the results of the two observers must agree in the same metal; or whether it is really necessary to determine the expansion of each piece

* The meter used by Mr. Hassler in his comparisons, and which the Chevalier Bessel suspects to have been too short, was *an original issued by the French commission*, and is therefore far more authentic than the *copies* used by Kater. We are happy, however, to be able to state, that Mr. Hassler has recently been engaged at Washington in further comparisons, and will probably make his results public in a short time. They are said fully to confirm his former experiments.

of

of metal in particular; I fear that without this inquiry there must always remain an uncertainty in respect to the comparisons of standard measures*.

Among the various copies of the toise, which Mr. Hassler compared with the English scale, that constructed by Lenoir and compared by Messrs. Bouvard and Arrago appears worthy of being accepted as authentic. When both measures are at the temperature of melting ice, this toise measures 76·74192710 inches of the scale of Troughton. By the normal temperature of both, $= 76{\cdot}74192710 \frac{1{\cdot}0002036843}{1{\cdot}0003152709} = 76{\cdot}73336$ English inches.

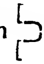
As the meter is = 443·296 lines of the toise (*Base Metrique*, tom. iii. page 433), the proportion between the English and French feet, according to Mr. Hassler, will be by the

$$\text{meter} = \frac{39{\cdot}36861}{443{\cdot}296} 12 = 1{\cdot}0657063,$$

$$\text{toise} = \frac{76{\cdot}73336}{72} = 1{\cdot}0657411.$$

According to Kater's comparison it is = 1·0657652.

It appears then, that the different copies of the meter do not always agree together. Mr. Hassler deduced from several comparisons the value of the meter in parts of the toise, but this I consider is not allowable; for the ratio between the two is determined by a law, by which the meter has received its true definition; and the earlier one, that it shall be the ten-millionth part of the earth's quadrant, was lost. If certain copies of these measures do not agree together, it shows only that the law is not exactly fulfilled by them; and as it is much more difficult to transfer to another metallic bar 443,296 lines of the toise than the whole length of the toise, the comparison of the meter is a circuitous and unprofitable way, as long as the toise itself is yet obtainable as easily as it was at the time of the construction of the meter.

The apparatus which Mr. Hassler had constructed for the measurement of the base line, differs essentially from all that are known to me; therefore I will describe it somewhat more particularly. The ends of the bars are not planes, but cut out, so that viewed from above they present the form ; over this middle excavation the hair of the spider's web is stretched, which therefore indicates the end of the bar; over each of the

* Copies of the meter have been made of platinum, but it will be obvious from these remarks of Bessel, that it is by no means a fit substance for such purposes, inasmuch as it is both difficult to work and to free from adventitious substances.

ends

ends a compound microscope is placed, which stands upon a separate support, and therefore does not change its place when the bar is moved or taken away. When this microscope is placed over the spider's web, the place of the end of the bar is determined by it; the bar then can be taken away, and the other end of it can be made to coincide with the point where the first had been before seen to coincide with the cross strokes of the microscope, which in the mean time has retained its position independently. The microscope has the following arrangement: the object-glass consists of two half lenses of different foci, one of which makes, in the focus of the eye-glass, an image of the spider's web of the bar, and the other an image of two rectangular crossing black lines, drawn upon an ivory plate, which is fastened to the microscope: this arrangement can be elevated and lowered, and moved in two horizontal directions at right angles to one another. In the use, the stand being first properly placed, the microscope is brought to that elevation in which the spider's web thread is distinctly visible, then it is moved until this thread appears exactly to cut the cross upon the ivory plate; the bar is then removed and advanced one length forwards, the end of it is next brought into the proper position by the mechanism of the bar, and it is moved by it until the spider's web of this other end coincides again by an optical contact with the cross on the ivory plate. Of these microscopes there are three with all their arrangements; the last ones always remain standing during the next subsequent operation, that in case of any accident the work might be begun again from them. The bar itself is a junction of four pieces, each of two meters in length, held together by iron clamps; the inclination of this bar to the horizon is measured by a sector, nearly as in Delambre's apparatus. When the work is interrupted during the night, the last position of the bar and the microscopes remain undisturbed in their position until morning. The arrangement of the boxes in which the bars are contained and the mechanism of the movements appear to me very well planned.

From what little I have quoted, it may be easily seen, that the paper of Mr. Hassler deserves the attention of those who take an interest in the mechanical arrangements necessary in practical astronomy and geodesy. It is to be lamented, that such a complete apparatus as that now on hand in America, has not been applied according to its intention and by its author.

F. W. Bessel.

LXIII. *On the Calculations requisite for predicting Occultations of Stars by the Moon. By Professor* Bessel.

[Concluded from p. 342.]

7. The quantities referring to the place of observation, viz. u, v, u', v', depend on the height of the pole and the sidereal time at that place. It is unnecessary to calculate ϱ and ϕ' separately, as we have

$$r \cos \varphi' = \frac{\cos \varphi}{\sqrt{(1-e^2 \sin \varphi^2)}}; \quad r \sin \phi' = \frac{(1-e^2) \sin \varphi}{\sqrt{(1-e^2 \sin \varphi^2)}}$$

where e denotes the eccentricity of the meridians of the earth. For Professor Encke's example, we have $\phi = 52° \, 31' \, 15''$, and the oblateness of the earth $= \frac{1}{302{\cdot}78}$, hence

$$\log . r \cos \phi' = 9{\cdot}78505$$
$$\log . r \sin \phi' = 9{\cdot}89752$$

If we denote by μ' the sidereal time, corresponding to the mean time T expressed in degrees, &c., the sidereal time corresponding to $T+t$ will be

$$\mu = \mu' + t \, . \, 54147''{\cdot}84,$$

and consequently $\sin(\mu - A) =$

$$\sin(\mu' - A) + 2 . \sin[t . 27073''{\cdot}92] . \cos[\mu' - A + t . 27073''{\cdot}92]$$

$$\cos(\mu - A) =$$

$$\cos(\mu' - A) - 2 \sin[t . 27073''{\cdot}92] . \sin[\mu' - A + t . 27073''{\cdot}92]$$

We have, therefore,

$$u = r . \cos \varphi' . \sin(\mu' - A)$$

$$v = r \sin \varphi' . \cos D - r . \cos \phi' \sin D \cos(\mu' - A)$$

$$u' = r . \cos \phi' . \frac{2 \sin[t . 27073''{\cdot}92]}{t} \cos[\mu' - A + t . 27073''{\cdot}92]$$

$$v' = r . \cos \varphi' \sin D . \frac{2 \sin[t . 27073''{\cdot}92]}{t} \sin[\mu' - A + t . 27073''{\cdot}92]$$

For facilitating the calculation of u' and v' there is a Table at the end of this paper which contains the values of

$$\log \frac{2 \sin[t . 27073''{\cdot}92]}{t} = \log \lambda$$

and ..... $t . 27073''{\cdot}92 = x$ for values of t between 0 and 1·5.

8. I shall now finish the example above adduced. For $T = 7^h$ the sidereal time will be $7^h \, 54' \, 7''{\cdot}264$, and therefore

$$\mu' = 118° \, 31' \, 49''{\cdot}0$$
$$\mu' - A = -50 \quad 42 \quad 17{\cdot}6$$

We obtain, therefore,

$$u = -0{\cdot}47177; \; v = +0{\cdot}75914$$

and next

$$m \sin M = p - u = -0{\cdot}19355$$
$$m \cos M = q - v = -0{\cdot}20674$$
$$M = 223° \, 6' \, 46''; \quad \log m = 9{\cdot}45210.$$

As

As a first approximation we assume the value of t in the quantities p', q', u', $v' = 0$, and obtain

$$\begin{array}{rclrcl}
p' &=& +0{\cdot}5240 & q' &=& -0{\cdot}1679 \\
u' &=& +0{\cdot}1013 & v' &=& -0{\cdot}0091 \\
\hline
n \sin N &=& +0{\cdot}4227\,; & n \cos N &=& -0{\cdot}1588 \\
N &=& 110^\circ\ 35'\ 26''\,; & \log n &=& 9{\cdot}65470
\end{array}$$

$$t = +0{\cdot}2402 \mp 0{\cdot}1690$$

or, Immersion $7^h{\cdot}0712$; Emersion $7^h{\cdot}4092$.

We next obtain for the second approximation by the formulæ of section 6.

	Immersion.	Emersion.
p'	$+0{\cdot}52402$	$+0{\cdot}52404$
q'	$-0{\cdot}16790$	$-0{\cdot}16791$

and by the Table at the end of this paper,

$\varkappa$	$+32'\ 7''{\cdot}7$	$+3^\circ\ 4'\ 38''{\cdot}6$
$\log \lambda$	$9{\cdot}41915$	$9{\cdot}41895$

by which we shall find next

$$\begin{array}{rll}
u' = \ldots\ldots & +0{\cdot}10250 & +0{\cdot}10780 \\
v' = \ldots\ldots & -0{\cdot}00907 & -0{\cdot}00873 \\
n \sin N = & +0{\cdot}42152 & +0{\cdot}41624 \\
n \cos N = & -0{\cdot}15883 & -0{\cdot}15918 \\
N = & 110^\circ\ 38'\ 47'' & 110^\circ\ 55'\ 41'' \\
\log n = & 9{\cdot}65365 & 9{\cdot}64898 \\
t = & \left\{\begin{array}{l} +0{\cdot}24026 \\ -0{\cdot}16857 \end{array}\right. & \begin{array}{l} +0{\cdot}23997 \\ +0{\cdot}16621 \end{array} \\
\hline
= & +0{\cdot}07169 & +0{\cdot}40618
\end{array}$$

The third approximation gives again the values of p' and q' obtained in the second approximation; and besides

$$\begin{array}{rll}
\varkappa \ldots\ldots & +32'\ 20''{\cdot}9 & +3^\circ\ 3'\ 16''{\cdot}9 \\
\log \lambda \ldots & 9{\cdot}41915 & 9{\cdot}41895 \\
u' = & +0{\cdot}10251 & +0{\cdot}10774 \\
v' = & -0{\cdot}00907 & -0{\cdot}00873 \\
n \sin N = & +0{\cdot}42151 & +0{\cdot}41630 \\
n \cos N = & -0{\cdot}15883 & -0{\cdot}15918 \\
N = & 110^\circ\ 38'\ 49'' & 110^\circ\ 55'\ 30'' \\
\log n = & 9{\cdot}65364 & 9{\cdot}64904 \\
t = & \left\{\begin{array}{l} +0{\cdot}24026 \\ -0{\cdot}16857 \end{array}\right. & \begin{array}{l} +0{\cdot}23996 \\ -0{\cdot}16625 \end{array} \\
\hline
= & +0{\cdot}07169 & +0{\cdot}40621
\end{array}$$

and as these results differ very little from the preceding ones, we may here conclude the calculation. We have therefore the times of the two phænomena = $7^h\ 4'\ 18''{\cdot}1$, and $7^h\ 24'\ 22''{\cdot}4$, and the angle denoted by $Q = 36^\circ\ 49'{\cdot}6$, and $5^\circ\ 9'{\cdot}2$.

9. Such

9. Such an accurate calculation is, however, not required when the circumstances of the occultation are only wanted for the purpose of making the observation; in that case an error of one minute is of no consequence; and if every thing requisite for this purpose only is wanted, it will be sufficient, provided t falls below, or at least does not much exceed one hour* to apply the following much shorter calculation. In place of

$$\frac{\cos\delta\,.\,\sin(\alpha-A)}{\cdot}\quad\text{and}\quad\frac{\sin\delta\,.\cos D-\cos\delta\,.\,\sin D\cos(\alpha-A)}{\sin\pi}$$

we put $\qquad \dfrac{\alpha-A}{\pi}\cos\delta \qquad$ and $\dfrac{\delta-D}{\pi}$

and neglecting the variations of $\cos\delta$ and π, so as to designate the right ascension and declination of the moon at the time T by α and δ and their hourly variations by $\Delta\alpha$ and $\Delta\delta$, we have

$$p=\frac{\alpha-A}{\pi}\cos\delta;\quad p'=\frac{\Delta\alpha}{\pi}\cos\delta;$$

$$q=\frac{\delta-D}{\pi};\qquad q'=\frac{\Delta\delta}{\pi}.$$

We next neglect t in the expressions for u' and v' and obtain

$$u=r\cos\varphi'\,.\,\sin(\mu'-A)$$
$$v=r\sin\varphi'\,.\cos D-r\cos\varphi'\,.\,\sin D\,.\cos(\mu'-A)$$
$$u'=r\cos\varphi'\,.\,\lambda\cos(\mu'-A)$$
$$v'=r\cos\varphi'\,.\,\lambda\sin(\mu'-A)\sin D$$

For the place to which the calculations refer, the logarithms of $r\cos\varphi'$ and $r\sin\varphi'$ are to be considered as known. If we write a for $r\cos\varphi'\sin(\mu'-A)$; b for $r\cos\varphi'\cos(\mu'-A)$; c for $r\sin\varphi'\cos D$, we have

$$u=a;\quad u'=b\,.\,\lambda;\quad v=c-b\sin D$$

$v'=a\,.\,\lambda\sin D$: where $\log\lambda=9{\cdot}4192$ and c may be taken from a small table which exhibits the value of this quantity for every degree of D with sufficient accuracy to four figures of decimals. The solution of equation (6) remains the same. In order to have a clear view of the calculation, I subjoin here the whole detail of it:

1830, April 5. 82 Leonis.

$$T=7^h;\ \mu'=118°\,32';\ \mu'-A=-50°\,42';\ \pi=54'{\cdot}18$$
$$\alpha=168°\,37'{\cdot}93;\ \delta=4°\,44'{\cdot}00;\ \Delta\alpha=28'{\cdot}50$$
$$A=169\ \ 14{\cdot}11\quad D=4\ \ 14{\cdot}08\quad \Delta\delta=-9{\cdot}08$$
$$\overline{-36{\cdot}18}\qquad\quad \overline{+29{\cdot}92}$$

* Should this supposition not be justified at the end of the calculation, or for other reasons a greater accuracy be desired, it may be obtained by a second approximation for u' and v' without changing p' and q'. It is easily seen that the error of the first approximation increases with the distance of the star from the path of the moon's centre, and that its limits cannot be unconditionally assigned.

$$\begin{array}{lllll}
 & \cos\delta & & & \\
l.(\alpha-A)=1\cdot5585n & -0\cdot0015 & l.r\cos\phi'=9\cdot7850 & & c=0\cdot7876 \\
l.\Delta\alpha\;\;=1\cdot4548 & -0\cdot0015 & l.\sin(\mu'-A)=9\cdot8887n & b & \sin D=0\cdot0285 \\
l.(\delta-D)=1\cdot4760 & & l.\cos(\mu'-A)=9\cdot8017 & & \\
l.\Delta\delta=0\cdot9481n & & l.a=9\cdot6737n & & \\
l.l\pi\;\;=8\cdot2662 & & l.b=9\cdot5867 & & \\
 & & l.\lambda=9\cdot4192 & & \\
 & & l.\sin D=8\cdot8683 & &
\end{array}$$

$$\begin{array}{lll}
p\;=-0\cdot6656 & u\;=-0\cdot4717 & l.m\sin M=9\cdot2876n \\
q\;=+0\cdot5523 & v\;=+0\cdot7591 & l.m\cos M=9\cdot3156n \\
p'=+0\cdot5242 & u'=+0\cdot1014 & l.n\sin N=9\cdot6261 \\
q'=-0\cdot1638 & v'=-0\cdot0092 & l.n\cos N=9\cdot1892n
\end{array}$$

$$M=223^\circ\,9';\; lm=9\cdot4525;\; N=110^\circ\,5';\; ln=9\cdot6533$$

$$l.\frac{m}{k}=0\cdot0171 \qquad l.-\frac{m}{n}=9\cdot7992n \qquad l.\frac{k}{n}=9\cdot7821$$

$$\begin{array}{lll}
l.\sin(M-N)=9\cdot9638 & l.\cos(M-N)=9\cdot5931n & l.\sin\psi=9\cdot4626 \\
\psi=16^\circ\,52' & +0\cdot247 & \mp 0\cdot176
\end{array}$$

$$\begin{array}{llll}
\text{Immersion} & 7^h\,4'\cdot3; & \text{Emersion} & 7^h\,25'\cdot4 \\
Q\;\ldots\ldots & 37^\circ\cdot0 & \ldots\ldots & 3^\circ\cdot2
\end{array}$$

10. The method of calculating which Mr. Encke has followed in constructing his Ephemeris for 1830, is perhaps as easy as the one here given; but it requires the previous calculation of some tables. The use of such tables not being required for the method here given, it will be easy for observers in other places to calculate every occultation for their horizons if the values of p, q, p', q' and the hour-angle of the star at the time T, viz. $\mu'-A$, which I will now denote by h, are given.

These data referring to the moon alone remain unchanged in the calculations for other places; only h is to be changed into $h+d$, where the positive d denotes eastern longitude from Berlin. For such a place we have

$$a=r\cos\phi'\sin(h+d)$$
$$b=r\cos\phi'\cos(h+d)$$
$$u=a; \qquad u'=b.\lambda$$
$$v=c-b.\sin D, \qquad v'=a.\lambda\sin D;$$

hence m, M, n, N, and lastly, the two values of t, which will show the mean time at Berlin, at the two moments in which the disappearance and reappearance will happen at the place for which the calculation has been made. This process will likewise be illustrated by calculating the occultation of 82 Leonis for Altona.

We assume as given:

$$T=7^h\left\{\begin{array}{l} p=-0\cdot6656,\; p'=+0\cdot5242 \\ q=+0\cdot5523,\; q'=-0\cdot1638\end{array}\right\} h=-50^\circ\,42'$$

For

For Altona we have

$l.r\cos\varphi' = 9{\cdot}77485,\quad l.r\sin\varphi' = 9{\cdot}90349,\quad d = -3^\circ\ 27'$

$$\begin{aligned} l.r\cos\varphi' &= 9{\cdot}7749 \\ l.\sin(h+d) &= 9{\cdot}9088n \\ l.\cos(h+d) &= 9{\cdot}7677 \\ l.a &= 9{\cdot}6837n \\ l.b &= 9{\cdot}5426 \\ l.\lambda &= 9{\cdot}4192 \\ l.\sin D &= 8{\cdot}8683 \end{aligned} \qquad \begin{aligned} u &= -0{\cdot}4827 \\ v &= +0{\cdot}7728 \\ u' &= +0{\cdot}0916 \\ v' &= -0{\cdot}0094 \end{aligned} \qquad \begin{aligned} c &= 0{\cdot}7986 \\ b\sin D &= 0{\cdot}0258 \end{aligned}$$

$$\begin{aligned} l.m\sin M &= 9{\cdot}2622n & M &= 219^\circ\ 40', & .m &= 9{\cdot}4571 \\ l.m\cos M &= 9{\cdot}3434n \\ l.n\sin N &= 9{\cdot}6361 & N &= 109^\circ\ 39', & l.n &= 9{\cdot}6621 \\ l.n\cos N &= 9{\cdot}1887n \end{aligned}$$

$$l.\frac{m}{k} = 0{\cdot}0217 \qquad l.\frac{m}{n} = 9{\cdot}7950n \qquad l.\frac{\kappa}{n} = 9{\cdot}7733$$

$$\begin{aligned} l.\sin(M-N) &= 9{\cdot}9729 & l.\cos(M-N) &= 9{\cdot}5344n & l.\sin\psi &= 9{\cdot}1951 \\ \psi &= 9^\circ\ 1' & &+ 0{\cdot}214 & &\mp 0{\cdot}093 \end{aligned}$$

Immersion $7^h\ 7'{\cdot}3$; Emersion $7^h\ 18'{\cdot}4$ Berlin time.
$= 6\ 53{\cdot}5$ . . . . . $7\ \ 4{\cdot}6$ Altona time.
$Q = 28^\circ{\cdot}7$ . . . . . $10^\circ{\cdot}6$

Auxiliary Table *for the Calculations requisite for predicting Occultations of Stars.*

t	log λ	κ	t	log λ	κ
		° ′ ″			° ′ ″
0·00	9·41916	0 0 0·0	0·19	9·41911	1 25 44·1
0·01	916	0 4 30·7	0·20	911	1 30 14·8
0·02	916	0 9 1·5	0·21	910	1 34 45·5
0·03	915	0 13 32·3	0·22	910	1 39 16·3
0·04	915	0 18 3·0	0·23	909	1 43 47·0
0·05	915	0 22 33·7	0·24	908	1 48 17·7
0·06	915	0 27 4·4	0·25	908	1 52 48·5
0·07	915	0 31 35·2	0·26	907	1 57 19·2
0·08	915	0 36 5·9	0·27	907	2 1 50·0
0·09	915	0 40 36·7	0·28	906	2 6 20·7
0·10	914	0 45 7·4	0·29	905	2 10 51·4
0·11	914	0 49 38·1	0·30	904	2 15 22·2
0·12	914	0 54 8·9	0·31	904	2 19 52·9
0·13	913	0 58 39·6	0·32	903	2 24 23·7
0·14	913	1 3 10·4	0·33	902	2 28 54·4
0·15	913	1 7 41·1	0·34	901	2 33 25·1
0·16	912	1 12 11·8	0·35	900	2 37 55·9
0·17	912	1 16 42·6	0·36	899	2 42 26·6
0·18	912	1 21 13·3	0·37	899	2 46 57·4

Table

Table *continued.*

t	log λ	κ	t	log λ	κ
		° ′ ″			° ′ ″
0·38	9·41898	2 51 28·1	0·81	9·41834	6 5 29·9
0·39	897	2 55 58·8	0·82	832	6 10 0·6
0·40	896	3 0 29·6	0·83	830	6 14 31·4
0·41	895	3 5 0·3	0·84	828	6 19 2·1
0·42	894	3 9 31·1	0·85	825	6 23 32·8
0·43	893	3 14 1·8	0·86	823	6 28 3·6
0·44	891	3 18 32·5	0·87	821	6 32 34·3
0·45	890	3 23 3·3	0·88	819	6 37 5·1
0·46	889	3 27 34·0	0·89	817	6 41 35·8
0·47	888	3 32 4·8	0·90	815	6 46 6·5
0·48	887	3 36 35·5	0·91	812	6 50 37·3
0·49	885	3 41 6·2	0·92	810	6 55 8·0
0·50	884	3 45 37·0	0·93	808	6 59 38·8
0·51	883	3 50 7·7	0·94	805	7 4 9·5
0·52	882	3 54 38·4	0·95	803	7 8 40·2
0·53	881	3 59 9·2	0·96	801	7 13 11·0
0·54	879	4 3 39·9	0·97	798	7 17 41·7
0·55	878	4 8 10·7	0·98	796	7 22 12·5
0·56	876	4 12 41·4	0·99	793	7 26 43·2
0·57	875	4 17 12·1	1·00	791	7 31 13·9
0·58	874	4 21 42·9	1·01	788	7 35 44·7
0·59	872	4 26 13·6	1·02	786	7 40 15·4
0·60	871	4 30 44·4	1·03	783	7 44 46·1
0·61	869	4 35 15·1	1·04	781	7 49 16·9
0·62	868	4 39 45·8	1·05	778	7 53 47·6
0·63	866	4 44 16·6	1·06	775	7 58 18·4
0·64	865	4 48 47·3	1·07	773	8 2 49·1
0·65	863	4 53 18·1	1·08	770	8 7 19·8
0·66	861	4 57 48·8	1·09	767	8 11 50·6
0·67	860	5 2 19·5	1·10	765	8 16 21·3
0·68	858	5 6 50·3	1·11	762	8 20 52·1
0·69	856	5 11 21·0	1·12	759	8 25 22·8
0·70	854	5 15 51·7	1·13	756	8 29 53·5
0·71	853	5 20 22·5	1·14	753	8 34 24·3
0·72	851	5 24 53·2	1·15	751	8 38 55·0
0·73	849	5 29 24·0	1·16	748	8 43 25·8
0·74	847	5 33 54·7	1·17	745	8 47 56·5
0·75	845	5 38 25·4	1·18	742	8 52 27·2
0·76	844	5 42 56·2	1·19	739	8 56 58·0
0·77	842	5 47 26·9	1·20	736	9 1 28·7
0·78	840	5 51 57·7	1·21	733	9 5 59·5
0·79	838	5 56 28·4	1·22	730	9 10 30·2
0·80	836	6 0 59·1	1·23	727	9 15 0·9

Table

Table *concluded.*

t	log λ	$\varkappa$	t	log λ	$\varkappa$
		° ′ ″			° ′ ″
1·24	9·41724	9 19 31·7	1·38	9·41678	10 22 42·0
1·25	721	9 24 2·4	1·39	674	10 27 12·8
1·26	717	9 28 33·2	1·40	671	10 31 43·5
1·27	714	9 33 3·9	1·41	667	10 36 14·2
1·28	711	9 37 34·6	1·42	664	10 40 45·0
1·29	708	9 42 5·4	1·43	660	10 45 15·7
1·30	705	9 46 36·1	1·44	657	10 49 46·5
1·31	701	9 51 6·8	1·45	653	10 54 17·2
1·32	698	9 55 37·6	1·46	649	10 58 47·9
1·33	695	10 0 8·3	1·47	646	11 3 18·7
1·34	691	10 4 39·1	1·48	642	11 7 49·4
1·35	688	10 9 9·8	1·49	638	11 12 20·2
1·36	685	10 13 40·5	1·50	635	11 16 50·9
1·37	681	10 18 11·3			

F. W. Bessel.

LXIV. *On some Optical Phænomena.* *By Dr.* J. Stokes*.

As facts are the groundwork of science, and the communication of facts to those that love it the only means of its advancement, I shall give a detail of several optical phænomena of very rare occurrence, and also of some experiments on the transmission of light through very small holes.

On the 25th of August in this year, between 7 and 8 A.M., I witnessed the following:

There was a westerly wind, and the sky was thickly strewed with light fleecy clouds, so small as to resemble flocculi, and so numerous as to form a continuous layer. These were moving with great rapidity towards the sun. In fig. 1, let the point *a* represent the zenith, and *a a″* a line passing from thence to the sun. This line appeared to me to pass through the points of contact that four arches *b c*, *d e*, *f g*, *h i* made with one another. They were rather faint, but exhibited prismatic colours; those of *b c* being the most perfect, those of *h i* the least: *f g* cannot be properly called an arch. Its form possessed rather a striking analogy to that of a well-known curve; *b c* appeared to be an arc of 60° to a circle whose radius was in the zenith *a*, and its chord I think parallel to the horizon; its two extremities *b* and *c* were well defined: but those of *d e* were not so; one of them, *d*, extending indefinitely on that side.

* Communicated by the Author.

The

The extremities of the remaining two were well defined, the lines connecting them being also parallel to the horizon.

The distance from the point of contact of *b c* and *d c* to that of *f g* and *h i* was about 20°. The radius of the circle *b c* about 10°.

The air was rather damp, and the barometer also was inconstant, varying with great rapidity.

I shall now mention the second of these phænomena.—In the month of July 1825, at 5½ A.M., I had ascended Garry-Castle (one of the highest of the Dublin mountains) to the elevation of about 1200 feet above the sea, and 1000 above the bottom of a deep valley situated at its base. A dense cloud had been hanging on the summit the whole morning, and into its gloomy twilight I entered. It was sinking slowly down the mountain into the plain, partly hanging over the valley; in consequence of which I soon found the fog decreasing, and the tops of the surrounding mountains dimly revealing themselves. At this time I had my back to the valley; and my face being towards the sun, (which was now breaking through the mist,) I happened to turn about, when I saw suspended over the former a brilliant semicircular arch of white light, exactly opposite the sun, and with a radius of about 40°. The breadth of the bow could not be exactly guessed at, because the light was more brilliant at its central part than at the edges, towards which it gradually faded away. It could not, however, have exceeded about 5°.

Its dissolution was caused in about five minutes, by the cloud sinking away into the valley and sailing into the plain. Towards the conclusion the band of light assumed a blueish hue towards the ground, the sun shining then more strongly.

The cloud in which I was enveloped seemed to me to be composed of minute bubbles floating about, and apparently about one-fifth the size of a pin's head. The reflection of the sun's rays from the sea had a peculiar yellow colour, and that from the watery particles of the cloud caused him to be lost and confused in a surrounding blaze of light. This was towards the end of the phænomenon, when the fog was becoming less dense than before. The arch was quite transparent. Some objects about twenty yards off were visible through it. No secondary bow was any where seen. Saussure, I believe, remarked that a cloud which surrounded him on the Alps, was composed of minute globules.

I shall next describe the experiments on minute holes.—I punctured a minute hole in a card, and having held it up to the light and applied my eye to the hole, I placed a pin between them. Immediately I saw an enormous and indi-

 stinct

stinct image inverted apparently on the other side. When I moved the pin downwards, the image moved upwards; and *vice versâ*, showing that it was inverted. When the hole was oblong instead of circular, I found that if the pin was placed in a direction perpendicular to the shorter axis, the image assumed the appearance of *i* in the oblong delineated in fig. 2. When it was very oblong, and the pin placed perpendicularly to its longest axis, the image was like two indistinct lines. If it is in the form of a long rectangle, nearly the same phænomena occur. But in that of an equilateral triangle, the image always appeared like indistinct lines.

In fig. 3. let *i* represent a small lens, *p* a pin placed between it and the point *f* its focus, and *e* a minute hole in a card placed beyond the point *f* at *h*. When all these things were in the above position, I looked through the lens and saw a magnified and pretty distinct image of the pin beyond the minute hole, and bordered with a bright fringe of light. The image is represented in the figure by the two concentric circles *i* and *s s'*, the annulus between being that fringe. When I moved the card further from the focus, the image became larger and more distinct; and when the pin was moved nearer to that point, it became smaller and more confused. The image was erect: but when *both* the pin and the hole were placed *between* the focus and lens, it became inverted and confused; and the same phænomena followed on the removal of the lens: and when they were both *beyond* the focus, the image was erect, but greatly confused.

When the diameter of the pin-hole is increased to more than one-fifth of an inch, all phænomena cease to be presented by it.

A very peculiar kind of telescope may be constructed from a moistened piece of silver paper and a minute hole in a circular piece of card both fitted up in a tube. It is represented in fig. 4, where an inverted and magnified image of the object *r x* is depicted on the paper *s s'*, and transmitted from thence to the eye at *e*. The image is confused.

The sun may be looked at through this instrument without the intervention of smoked glasses.

When *s' p* is increased to the length of several feet, *s a'* continuing stationary at four inches, if the observer looks through it at the sun, he will appear of increased size and of an oval form. An increase of the magnifying power (by increasing *s p'*) makes it more elliptical. A decrease makes it less until at length it reassumes the circular form.

Dublin, Sept. 25, 1829. JOHN STOKES.

Zenith.

Fig. 1.

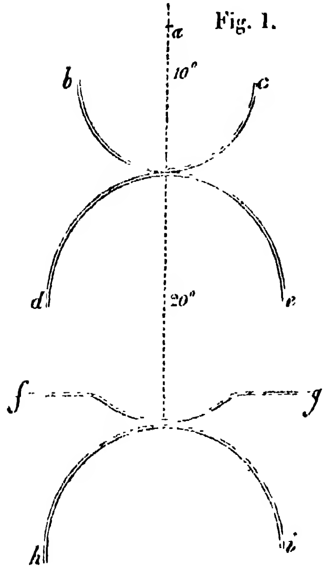


Fig. 2.

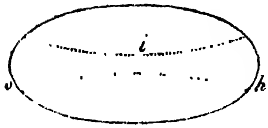


Fig. 3.

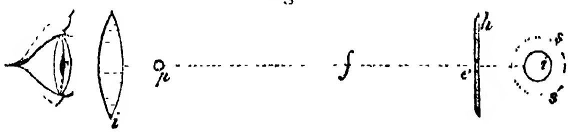
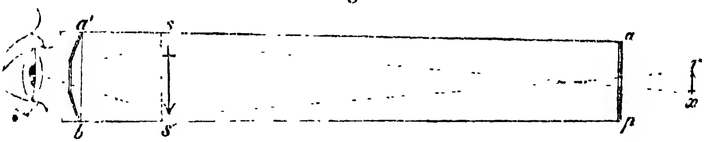


Fig. 4.



LXV. *Experiments on the Modulus of Torsion.* *By* Benjamin Bevan, *Esq.**

NUMEROUS experiments have already been published on the strength of wood and other substances, as far as regards their cohesion and elasticity; but I am not aware of any extensive table of the modulus of torsion of different species of wood, deduced from experiments conducted upon a proper scale, and with the necessary care.

* From the Philosophical Transactions for 1829. Part I.

To

To supply this defect, and to furnish the practical engineer and mechanic with useful data, and with rules for their application, is the object of the present communication, consisting of a copious table of the results of my experiments, made at various times, and upon substances of considerable variety of dimensions within the ordinary limits of practice.

It is proper to observe, that the various specimens of wood upon which my experiments were made, were sound and dry, except it is otherwise expressed or described, and were in general free from all large knots.

Considerable care was used to obtain correct dimensions of the specimens under experiment, by means of a simple instrument, which answers the purpose of improved callipers, by which the dimensions of the specimens were measured, and read off by a magnifying-glass to the 400dth part of an inch. Previous to trial, each specimen was brought to a prismatic form, as near as could be wrought by the ordinary means, and the dimensions afterwards taken by means of the improved callipers above mentioned, at equal distances; and the mean breadth and thickness thus obtained, were used in the calculations for obtaining the modulus. My experiments were often repeated on the same species of wood, under considerable variations of length, breadth, and thickness; and always with the most satisfactory results; viz. from nine to ninety inches in length, and from three inches to three-tenths of an inch in thickness. Due care was observed to prevent any error in the apparent torsion or twist arising from compression at the ends of the prisms, both at the clamp by which they were fixed, and at the radial lever at which the successive weights were applied; two sources of error which have materially affected former experiments on this subject, in other respects carefully made.

To every specimen under experiment I attached two indexes; one a few inches from the end fixed in the clamp or vice, and the other at a small distance from the attachment of the lever or wheel, where the weight or straining power was applied; and the distance between the two indexes was used as the length for calculating. Another error of less magnitude I have been able to avoid by fixing a pivot or small gudgeon at the supported end, in the line of the axis of the prism, instead of making the lower side or angle of the prism at the supported end the revolving point.

My experiments were made upon prisms of very different proportions as to breadth and depth, viz. from $\frac{1}{30}$th to equality.

In general practice, the square or cylindrical shaft is usually adopted,

adopted, and as a cylindrical spindle or shaft of $\frac{1}{7}$th more in diameter than the side of a square shaft will possess nearly the same stiffness in resisting a twisting force, it will, I presume, be sufficient in this place to give the rule for calculating the deflection of a square prismatic shaft, to which I shall add one example by way of illustration.

Rule.—To find the deflection δ of a prismatic shaft of a given length l when strained by a given force w in pounds avoirdupoise acting at right angles to the axis of the prism, and by a leverage of given length $= r$; the side of the square shaft $= d$. T, being the modulus of torsion from the following table; l, r, δ, and d, being in inches and decimals,

$$\frac{r^2 l w}{d^4 T} = \delta$$

i. e. for a numerator, the square of the radius of the wheel or leverage multiplied into the length, and this product by the weight in pounds: and for a divisor, multiply the fourth power of the side of the square prism by the tabular modulus of torsion: divide the former by the latter, and the quotient will be the deflection or quantity of twisting in inches and decimals when measured at the end of the radius r. As an example, let there be a square* shaft of English oak 50 inches long and 6 inches by 6 inches, subject to a strain of 3000 lbs. at the circumference of a wheel of 2 feet in diameter, or having a leverage of 12 inches†.

$6 \times 6 = 36$	$12 \times 12 = 144$
36	$50 =$ length
1296	7200
20000	$3000 =$ force
25920000	$25920000)21600000(0{\cdot}83 =$ deflection,

* If the transverse section of the prism or shaft be not a square, but a parallelogram, let $b =$ the breadth, and d the depth: the deflection will be obtained by the following formula:

$$\frac{(d+b)\, l\, r^2 W}{2 b d^3 T} = \delta.$$

† If the measure of torsion should be required in degrees (Δ)

$$\text{let } \varrho = 57{\cdot}29578 \quad \text{then } \frac{r \varrho l w}{d^4 T} = \Delta$$

$$\text{or let } \frac{T}{\varrho} = t \quad \text{then } \frac{r l w}{d^4 t} = \Delta$$

$$\text{thus for wrought iron and steel } \frac{r l w}{31000 d^4} = \Delta$$

$$\text{cast iron } \frac{r l w}{16600 d^4} = \Delta$$

or

or nearly $\frac{5}{6}$ths of an inch. And as the deflection will be directly as the force, a weight or force of 300 lbs. would produce a deflection of $\frac{1}{12}$th of an inch.

Table of the Modulus of Torsion.

Species of Wood.		Modulus of Torsion. lbs.
Acacia (not quite dry)	sp. grav. ·795	28293
Alder (crossed-grained)	sp. grav. ·55	16221
Apple	sp. grav. ·726	20397
Ash (of my own planting)		20300
Ash (mountain)	sp. grav. ·449	13933
Beech		21243
Birch		17250
Box (old, and very dry)	sp. grav. ·99	30000
Brazil wood (old, and very dry)	sp. grav. 1·05	37800
Cane (influenced by the hard surface)		21500
Cedar (scented)		12500
Cherry	sp. grav. ·71	22800
Chesnut (sweet)		18360
Chesnut (horse)	sp. grav. ·615	22205
Crab	sp. grav. ·763	22738
Damson		23500
Deal (Christiana)	sp. grav. ·38	11220
Elder	sp. grav. ·755	22285
Elm		13500
Fir (Scotch)		13700
Hazel (not quite dry)	sp. grav. ·83	26325
Holly		20543
Hornbeam (not quite dry)	sp. grav. ·86	26411
Laburnum (green, or fresh cut)		18000
Lance-wood	sp. grav. 1·01	25245
Larch	sp. grav. ·58	18967
Lime or Linden	sp. grav. ·675	18309
Maple (partly cross-grained)	sp. grav. ·735	23947
Oak (English)		20000
Oak (Hamburgh)	sp. grav. ·693	12000
Oak (Dantzic)	sp. grav. ·586	16500
Oak (from Bog)	sp. grav. ·67	14500
Ozier		18700
Pear	sp. grav. ·72	18115
Pine (St. Petersburgh, fresh)		10500
Pine (St. Petersburgh, four or five years old)		13000
Pine (Memel)		15000
Pine (American)		14750

Plane

Species of Wood.		Modulus of Torsion. lbs.
Plane	sp. grav. ·59	17617
Plum	sp. grav. ·79	23700
Poplar	sp. grav. ·333	9473
Satin-wood	sp. grav. 1·02	30000
Sallow		18600
Sycamore		22900
Teak (old, and partially decayed)		16800
Teak (African)		27300
Walnut	sp. grav. ·572	19784

I have observed in a great number of my experiments, that the modulus of torsion bears a near relation to the weight of the wood when dry, whatever may be the species; and that for practical purposes we may obtain the deflection (δ) from the specific gravity (s). Thus

$$\frac{r^2 l w}{30000 d^4 s} = \delta.$$

Table of the Modulus of Torsion of Metals.

	Modulus of Torsion. lbs.
Iron, English (wrought)	1810000
Iron, English (wrought)	1740000
Iron, thin hooping	1916000
Steel	1984000
Steel	1648000
Steel	1618000
Iron cylinder	1910000
Iron cylinder	1700000
Iron square	1617000
Iron square	1667000
Iron square	1951000
Mean of Iron and Steel	1779090
Iron (Cast)	940000
Iron (Cast)	963000
Iron (Cast)	952000
Mean of cast-iron sp. grav. 7·163	951600
Bell-metal sp. grav. 8·531	818000

On comparing these numbers with the modulus of elasticity of the same substance, I find the modulus of torsion to be $\frac{1}{16}$th of the modulus of elasticity in metallic substances.

LXVI. *On*

LXVI. *On the System of Prize Chronometers at Greenwich.* *By* CALEB MAINSPRING.

To the Editor of the Philosophical Magazine and Annals.

Sir,

AS your valuable Journal is open to all subjects of general interest and utility, I trust I may be favoured with an opportunity, through you, of laying before the public some circumstances affecting my own particular case, and which will, no doubt, sooner or later, equally affect many others in my situation.

You must know then, Sir, that I am a watchmaker by trade, having recently attempted to set up for myself, after serving a seven years apprenticeship to one of the most celebrated in that line. But, unfortunately for me, I cannot succeed: not that there is not encouragement enough for articles of that kind, from the gilt bauble that hangs by the fair lady's side, to the exquisite finish of the astronomer's time-piece. But, then it is necessary to have a *name*, otherwise the *trash* which is made, even by the best of the trade, will never go off. Now, unfortunately for me, instead of being a Harrison, a Breguet or a Pennington, I am about one of the very worst mechanics that ever existed. I never yet could make a chronometer that was good for any thing: and I had almost in despair given up the trade altogether, and applied myself to something else that does not require so much talent or genius, when I accidentally cast my eye over the list of Prizes offered by the Admiralty "for chronometers that keep time agreeably to a "certain rule laid down by the late Board of Longitude."

Now, Sir, although I acknowledge that I am a great bungler at the lathe and the file, at pivots and at rackwork, and all the other nice operations by which that beautiful piece of mechanism (the watch) is produced, yet I must confess (and I pride myself not a little on the acquisition) that I have some slight knowledge of figures, and of the various combinations of numbers; so that when a rule in arithmetic, however intricate and obscure, is laid before me, I can immediately see through all its various ramifications and bearings, and trace the result with great accuracy. I immediately fancied therefore that I saw, in this patriotic plan of Government, a favourable opportunity, not only of making, instanter, a little ready money, but also (like many others in the world) of gaining some notoriety and renown for points which, I have candidly confessed to you, I do not understand.

The

The *trial number* (as it is technically called), or the rule by which the prizes at Greenwich are distributed, is ascertained "by taking the difference of the greater and lesser monthly "rates of each chronometer, multiplying that difference by 2, "and adding thereto the mean of the monthly extreme varia- "tions:" and that trial number which, by this process, comes out the *least*, is entitled to the highest prize*. I shall not stop to examine the elegance of this enunciation, nor the accuracy of the reasoning on which it is founded, as its propriety and justness must and ought to be duly acknowledged and appretiated, when we learn that it was the deliberate result of a Committee of the late Board of Longitude, assembled for that express purpose, and signed in due form and order by five or six of the most distinguished members of that Board. And although some naughty folks have been bold enough lately to throw out insinuations against that Board, as if there was always some interested motive mixed up with their proceedings, yet my motto is *De mortuis nil nisi bonum:* and, in this instance, I can have no reason to complain, since I mean to profit so much by it myself:—and since the plan (as I shall now proceed to show) not only encourages the good workman, but also holds out a reward to those who, like myself, never could make a watch fit even for a lady's toilet.

By way of experiment I borrowed one of my late master's very best chronometers (one that he proposed to deposit at the Observatory, as a candidate for the prize), and having compared it day by day, for two months, with one of my own ordinary watches (one, indeed, that had been hanging up a long time in my shop window without a chance of its ever being sold), I found that the scheme would succeed, and that my name would soon be sounded abroad as having run away with all the prizes at Greenwich. The following is the result of my experiment: and I leave you to judge, Mr. Editor, of the delight I experienced, as I watched from day to day (almost with a sneer upon my countenance) the slow and stupid progress of my master's dull piece of mechanism, which did not vary for many days together: whilst mine, as if actually anticipating the high honours to which it was about to be raised, skipped about with an hilarity equal to my own, and could not be depended on for two days, or even for two hours together.

* This is the official wording of the rule as *translated* for the benefit and convenience of the humble mechanic. The original document (which I may probably give at some future time) is very long, and much too sublime for our vulgar ears.

Days.	My Master's Chronometer. No. 1.		My own common Watch. No. 2.	
	April.	May.	April.	May.
1	+5·0	+6·0	+6·2	+9·0
2	5·0	5·7	6·4	5·2
3	5·0	6·0	7·0	7·6
4	5·0	6·2	5·4	6·0
5	5·0	6·4	8·0	9·0
6	5·0	6·6	7·4	5·6
7	5·0	6·8	6·8	6·2
8	5·0	6·8	6·2	8·0
9	5·0	6·8	9·0	7·0
10	5·0	6·8	6·6	6·4
11	5·0	6·8	6·0	6·6
12	5·0	6·8	9·0	7·4
13	5·0	6·8	5·8	6·0
14	5·0	6·8	6·2	5·8
15	5·0	6·9	6·6	6·8
16	5·0	6·9	5·9	7·3
17	5·0	6·8	7·3	5·9
18	5·0	6·8	7·7	6·6
19	5·1	6·9	5·2	6·2
20	5·2	6·8	7·2	7·2
21	5·3	6·8	5·8	8·8
22	5·4	6·9	6·6	5·4
23	5·5	6·8	5·2	6·4
24	5·6	6·9	7·4	5·8
25	5·7	6·9	8·0	5.2
26	5·8	6·9	5·2	8·2
27	5·9	6·8	7·6	5·2
28	6·0	6·8	8·1	7·6
29	6·1	6·9	5·4	8·0
30	6·2	6·9	8·8	7·6
Mean monthly Rate	=5·26	6.70	6·80	6·80
Greatest diff. or extreme variation ...	=1·20	1·20	3·80	3·80

As my master's chronometer, which I shall call No. 1, might be trusted, as to the regularity of its rate, for twelve months together; and as my own watch, which I shall call No. 2, might also be equally depended upon for its *ir*regularity; I have taken these two months as a fair specimen of what would

would be the issue at the end of the year, and as the test of my scheme. Now then for the result:

No. 1.	Greatest mean monthly rate	....	″6·70
	Least ditto	....	5·26
		Difference...... =	1·44
			2
			2·88
	Greatest extreme variation in April = 1·20, in May = 1·20	Mean ...... =	1·20
		Trial number ... =	4·08
No. 2.	Greatest mean monthly rate	....	6·80
	Least ditto	....	6·80
		Difference...... =	0·00
	Greatest extreme variation in April = 3·80, in May = 3·80	Mean........ =	3·80
		Trial number... =	3·80

And my *trial number*, being the *least*, consequently runs away with the prize. Now as I have several other watches that, by a little shaking or so, I could soon put into a proper training for this sort of prize-fighting, I already anticipate the whole of the rewards offered by Government.

But now, Mr. Editor, here comes a difficulty which I did not at all foresee or contemplate. I had intended my scheme to be a profound secret. I meant to deposit my watches, with all due solemnity, at the Observatory: and I already fancied that I saw Mr. Taylor (when he came, day after day, applying his Ithuriel's spear to my miserable production) shake his head and advise me to *withdraw* it: whilst I, conscious of my success, would laugh in my sleeve and treat his honest intentions with unmerited disdain. But I could not keep the secret locked up in my own breast: and in the fullness of my heart I communicated it to my quondam fellow apprentice, a lad more conversant with the world than I am: and who has been recently admitted into the club of master clock-makers, that meet every Monday night at the "Tippling Philosopher" in Liquorpond-street. He, alas! has thrown a damp on all my projects, and blighted all my hopes: and I fear that if his predictions be verified, all my schemes will be blown to atoms. He tells me that they are a cunning set of people at the Admiralty, who have a will of their own and will not be dictated to: that they snap their fingers at the Board of Longitude,

whom they call a parcel of old women, for whose opinions they don't care a fig, and whose cable (to use one of their own phrases) they cut, and set them adrift determined to direct their own vessel themselves. But, Sir, as my old master used often to say "A bargain is a bargain:" and if they have offered these rewards, and laid down a scale by which they are to be distributed, surely they cannot have the assurance (bold as they may be) to run contrary to their engagements. Besides, Sir, will they pretend to set up *their* opinion in opposition to the late Board? will they venture to say that because the watch *appears* to go irregularly, it is a bit the worse for that? What do they know about science? "What is science to "them, or they to science?" And so little are they acquainted even with the elements of it, that my fellow 'prentice tells me that the club very often quiz them, and say that they are still in leading strings, and have three learned *advisers* at the public expense to keep them from going adrift when any thing difficult occurs. But this is not generally known, since it is kept snug and quiet to themselves, as if they were ashamed of it. What then should they know of the beautiful and sublime truths that are hidden in the guise of an analytical expression, or the obscure wording of an arithmetical rule? will they venture to oppose (except by a stretch of arbitrary power, which I now begin to dread) the solemn document of some of the first mathematicians of the age, who have declared and pledged themselves that those watches, which fulfill the rule they have laid down, are *deserving the highest reward?* Under these circumstances I trust that all bad watch-makers will make common cause with me, and resist the innovation which I have now too great reason to fear may be attempted.

Trusting that these remarks will excite a little spirit of inquiry into this subject, I remain your very obedient servant,

Clerkenwell, Nov. 16, 1829. C. M.

LXVII. *On the Cultivation of Botany in England. By Professor* SCHULTES, *of Landshut.*

[Concluded from p. 366.]

THE garden of the Horticultural Society at Turnham Green, scarcely half an hour's distance from Kew, is of far greater importance to the art of gardening, which is indeed the proper design of the study of botany. This establishment, which is described in the Horticultural Transactions, is likely to prove of incalculable advantage to Britain and to all Europe: every branch of Horticulture except the ornamental, being here pursued to the greatest extent and according to the purest scientific

scientific principles; such as the cultivation of fruits and vegetables, both forced and in the open air; and of flowers, whether abroad or under glass. No less than thirty-three acres of land are destined to the accomplishment of the necessary experiments, surrounded by a lofty wall, and again walled off into partitions. By this plan, however, the Society appears to have intentionally sacrificed the picturesque. About forty workmen are kept in this Vineyard of the Lord, who are under the superintendence of a very able gardener, Mr. Munro. At present there are five stoves, two of them built after the newest plan, with convex windows, which are found to be highly advantageous. A very large house is to be erected next year, and heated by steam. We of Germany must long want a great advantage which the English possess in their stoves; namely, the very slender iron frame-work in which the panes of glass are inclosed, thus uniting durability with the advantage of admitting the greatest quantity of light. The price of these iron frames in England, where every thing is six times as expensive as with us in Bavaria, amounts to no more than what we should pay for a frame of wood that would not last above a year. The Horticultural stoves contain many valuable plants from China and Sierra Leone; brought by Mr. Don's brother, who had resided there for some time. So fine a collection of Roses exists no where else; the celebrated Mr. Sabine, who is secretary to the Society, having been engaged in studying this tribe for almost thirty years. They are arranged in large squares; one might almost say, in small groves of roses, native and foreign, single and double. On comparing this garden with those of the ancient universities of Cambridge and Oxford, one cannot for a moment hesitate in declaring the superior influence that this must have in benefiting the country; although it has only been formed within these few years, by the joint exertions of a few private individuals. The friend of mankind contemplates with pleasure how much more a well-directed Society of spirited men can effect in ten or twelve years, with the small sum of about 60,000 florins, raised among themselves, than has been performed by the two great learned bodies of the kingdom, with their millions. Whoever doubts the influence which the Horticultural Society has produced on the nation, or who thinks that our ideas of its value are overrated, we would advise him to attend one of their sittings, and there to see what is done by the members of this institution; and then, like that *wisest* of the Apostles, Thomas, when he shall have weighed in his hand what is sent thither, when he shall have tasted of the fruit, and inhaled the rich perfume diffused by pines, peaches and nectarines, he will perhaps satisfy

tisfy himself that it is not all a phantasmagoria.—We had the honour of being present at a meeting of the Society in September 1824, and we must confess that although conversant with the rearing of fruit for almost forty years, we had never beheld finer peaches, nectarines, plums, melons, grapes and pine-apples, than we saw here. We had been much disappointed in the London fruit-markets, where we certainly saw uncommonly fine-looking fruit; but on tasting, found them to be acid or insipid, compared with the produce of our southern hemisphere, in Tyrol, the South of France, and Lower Hungary: but after having enjoyed the flavour of the fruit here presented to us, it was easier for us to abandon our prejudices against this kind of English produce, than to conceive how so northern and foggy a climate could have brought to perfection such rich fruit; how Art has thus overcome the omnipotence of Nature.

The Horticultural Society possesses a very valuable pomological and botanical library, with a beautiful collection of models in wax of fruits, and two volumes of drawings made in China of native plants. The well-known Mr. Lindley, to whose kindness we owed our admission to the Society's collections, superintends here the botanical business of this establishment, and resides therefore at Turnham Green. Mr. Lindley is also engaged in several botanical publications, among which is the Botanical Register, in which he executes the work of Mr. Bellender Ker, alias Mr. Gawler, whose very bad health has compelled him to reside for some time at Boulogne.

In the same district with the two just-mentioned gardens,—namely at Chelsea, south-west of London,—is the celebrated *Hortus Chelseanus*, at one time under the direction of Miller, and particularly designed for the culture of officinal plants. Mr. Don was so obliging as to introduce us to the present curator, Mr. Anderson, a very amiable, open-hearted old man, who received us with Scottish kindness. Sloane's statue ornaments this garden, which possessing neither great size nor beauty, and still less elegance, yet includes, among the six thousand plants there cultivated, many very rare officinal vegetables, some which are to be found nowhere else. He who would here study botany has a rich field open to him, its value enhanced by Mr. Anderson's experienced remarks. There are standing in this garden, like twin brothers, two noble cedars planted by Miller's own hand; a *Pistacia Lentiscus* growing against a wall, and which he had raised from seed; and a *Platanus*, whose growth has made an increase of sixteen feet in circumference since the time of Miller. I saw here all the three species of *Platanus*, and was surprised at hearing that the

Occidental

Occidental Plane does not thrive well in the mild climate of England, as it shoots too early in the spring, and then suffers severely from the late frosts. I observed also *Sambucus nigra*, "foliis ternatis," which grows wild on the ruins of an old Roman wall in Wiltshire, but without perfect stamens, which it equally wants in the Chelsea Garden. Among the Succulents, particularly the Aloes, are many that were in the possession of Miller. Banks has also left here a memento of his youth, in the invention of an experiment that will outlive him, much as its success was doubted at first. Mr. Anderson confirms it, by saying that when a tree or shrub is inoculated with a variegated-leafed variety, the foliage of the grafted stem becomes also gradually variegated. He showed us a proof of it in a Jasmine, which was only budded with a variegated jasmine, and now covers a whole wall with its particoloured leaves. It is a question, whether this variegation may not be produced in the same way by inoculating variegated buds on any tree favourable to the development of the buds.

Besides a small botanical library, existing at the time of Miller, the herbariums of Catesby, Rand and Nicholls, are also preserved here in well-closed cases; they appear, however, to be but little used, for we found the top papers so covered with coal soot as to blacken our hands. It is sad to see how the coal smoke penetrates every where. There is a collection of seeds by the venerable Rand, whose beautiful arrangement may have suggested the leading idea of the work by the two Gærtners. The Chelsea Garden is continually receiving seeds from all parts of the world: a large collection, sent by Baron Field, who is a judge there, from New Holland, had just arrived. The liberal Mr. Anderson kindly offered us a portion of this valuable present, which we have divided again with other friends. Mr. Anderson related to us, not without painful feelings of just indignation, the history of the latter days of the immortal Miller. This zealous officer was dismissed in the most illiberal manner by one of the committee who then superintended the garden, as a reward for his unremitting services to the institution, as well as his extensive knowledge in gardening. He soon after died of grief, and left—nothing! Fifteen gardeners united, and subscribed a guinea each for a gravestone; but as just at that time the son of Miller returned from India with a fortune of 15,000*l.*, and it being naturally supposed that the opulent son would erect a monument to his parent, the simple stone was given up:—yet the son never thought of rearing a monument to his illustrious father. Sir Joseph Banks then set on foot a new subscription, to which he himself contributed five pounds; and

the

the opulent nurseryman and others soon raised a considerable sum: nevertheless this plan came to nothing, as the son was thereby offended. However, the young Miller died soon after, and had a monument erected for himself and his father together.

We also visited the garden of the cheerful Haworth, at Queen's Elms, near Chelsea, who indefatigably and exclusively studies the Succulent Plants, and possesses many extremely rare ones. More than 200 Aloes, 360 Mesembryanthema, and 90 Crassulæ, are in his collection. Mr. Haworth seems a very communicative and kind-hearted little man: he has the happiness already of being a grandfather, though in the prime of his age. We had wished to see the respectable Mr. Salisbury's garden; but were told that he had sold it, and was living with a friend in the country during the fine weather. We were sorry to lose the opportunity of being acquainted with this celebrated botanist. Fortunately, we had the pleasure of seeing in London the Nestor of the London botanists, who has already passed the eightieth degree of human latitude, —namely, the celebrated Dr. Sims, whom we found indefatigably employed in the continuation of the Botanical Magazine, although with a trembling hand, and a head bowing down under the ponderous weight of the reverend silver crown of age.

A no less venerable and highly amiable sage is the good old man of the mountains, (*e monte Grampio*,) Sir Archibald Menzies, of the Grampians, among which he was born, at Chapel Place, in the month of March 1754. (!) Flora has presented this valuable old man with a truly *viridem senectutem*, in reward for the homage which he offered to her in his twice repeated voyage round the world. "And were another expedition going, I would immediately set off again," said Sir Archibald to us. He has lately returned from an excursion to Scotland; when his countrymen on taking leave of him threw the *Menziesia**, accompanied with a thousand blessings, into the coach. He is now as active as a person of forty, and is in great practice as a surgeon in London. A neater herbarium than that of Sir A. Menzies I never saw: the Cyperaceæ and Gramineæ, as well as the Mosses and Ferns, (the

* We must really beg leave to question the accuracy of this anecdote. We had the happiness of receiving Mr. Menzies at our house in his return from the Highlands, and heard nothing of the story of the *Menziesia*. Nor can Dr. Schultes be aware of the extreme rarity of this plant. Scarcely a single botanist has seen it on its native mountains, not even Mr. Menzies himself; so that we well believe that if our venerable friend had been greeted with such a shower of his beautiful namesake, the day would have been one of the happiest of his life; and the freshly pulled specimens would have been at least as acceptable as the blessings which accompanied them.—Ed.

latter

latter are his favourites,) are laid out with the utmost care in octavo papers, and packed in cases, so as to be ready to be taken on board ship again at a moment's notice.

Sir Archibald Menzies informed us, with evident pleasure, that two of his countrymen (of Scotland) are about to enjoy the same privilege of travelling as his own youth had received;—a Mr. MacGray having been sent as a botanist, in that vessel which carried home the remains of the king of the Sandwich Islands, to the South Seas; and another, Mr. Douglas, being gone, in a similar capacity, to the Columbia River. A Mr. Frost, also, has visited America. From Menzies, too, we learned that Brodie, lieutenant of the county of Nairn and member of parliament, has lately died.

At Mr. Lambert's Museum we had the great good fortune to become acquainted with Dr. Richardson, the celebrated companion of Capt. Franklin in his expedition to Arctic America. This gentleman, who lives at Chatham, was so obliging as to show us his herbarium, which contains many rarities, and a great number of new species, particularly belonging to the genera *Ranunculus*, *Rubus*, and *Potentilla*. Before starting on the voyage which he will undertake next year in the direction of the North Pole,—for not all the ice of those frozen regions has power to cool his ardour in the cause of science,—Dr. Richardson will prepare a new edition of his Appendix.

Mr. Andrews the botanist was not at home; he is proceeding with his works on the *Ericæ* and *Gerania*.

At the British Museum we had expected to find a treasure of Natural History; but,—except Sloane's collection of dried plants in thirty volumes, and an herbarium which belonged to a Mr. Van Moll, with a small but well preserved set of British birds,—we found nothing that interested us at all. The department of Minerals is beautifully arranged by the celebrated German, Mr. König; but except some very rare unique specimens, it is inferior to the two collections at Paris, belonging to the Museum and the Ecole des Mines, as well as that of the Academy at Munich. Two tables that we saw here, covered with beautiful specimens of *Carpolitha*, would engage the attention of Count Sternberg for weeks; and he would be delighted to compare them with those treasures that he is himself so well acquainted with, and has so liberally communicated to the public. An immense building is in progress; with the addition of which the British Museum, now of inconsiderable size, will fill an entire square of the city of London. But to render this institution as rich in subjects of Natural History as it is in antiques, or as the Muséum d'Histoire Naturelle at Paris was, or as is the collection of Leyden in the department

of the animal creation, would be the work of half a century. It is really incredible that a nation, possessed of the greatest conquests, and making the most extended discoveries in all parts of the world, should have collected so scantily for its public Museum: and the more so, as England boasts of men of the most distinguished character in all branches of Natural History. How is it possible that the British can allow the two neighbouring nations whom they look down upon in many respects, to excel them in this way as much as they are outdone by them in others? This enigma would be to me perfectly inexplicable, if a solution to it were not afforded by the state of the two Universities of Oxford and Cambridge, where the science of Natural History is at so low an ebb.

Except the periodical works on Botany, and the Second Part of the publication on the genus *Pinus* by Count Lambert, we neither saw nor heard of any novelties in this department; except that we were informed that twenty sheets of Wallich's and Carey's *Flora Coromandeliana* had arrived in London. Mr. * * * * therefore was wrong, when he asserted with a haughty look three years ago, "A Second Part of this work will never appear!"

We have visited the celebrated flower-market of London; of which no German who has not seen it, could form a proper idea. What chiefly struck us is, that the greatest rarities and most trifling articles are here exposed for sale together, and that both are eagerly bought. Were such things to be carried to the *Marché aux Fleurs* at Paris, not a pennyworth of them would be sold. But by the two flower-markets of these two principal cities of Europe, an estimate of the different character of their inhabitants may be formed. The wealthy and respectable Englishman, who is a connoisseur, will purchase nothing that is common; for if pretty, he has it already in his garden;—and the poor Londoner who cannot afford to buy what is beautiful, will still obtain, if possible, something green to decorate the window of his dark little attic*, and give his last farthing for a bit of verdure. The opulent Frenchman, who values all objects only as they please the eye, without reference to their being common or scarce, is willing to

* Perhaps from the custom of the ancient Romans (for the English still retain traces of the manners of that people): "*jam in fenestris suis plebs urbana in imagine hortorum quotidiana oculis ruris præbebant, antequam præfigi prospectûs omnes coegit multitudinis innumeratæ sæva latrocinatio.*"—Plin. Nat. Hist. xiv. cap. 4. By this "præfigi prospectûs" is not that most shameful of all imposts, the window-tax comprehended, by which the people are in a measure deprived of that most universal of all Nature's gifts—*light*?

pay

pay a greater price for a lovely rose-bush, than for the rarest plant from New Holland or the Cape of Good Hope; and as to the poor artizan of the French capital, he only thinks of vegetable productions as they are fit for culinary uses; and whether they be blue or green to look at, is the same to him. Hence it arises that the Parisian flower-market offers a much more delightful vista than that of London, though it is much smaller and more poorly stocked; as the French capital itself cannot compare with London for extent or wealth.

If the French pave the squares of their city that they may afford a more agreeable promenade, the English change theirs into delightful lawns, which afford a prospect of verdure to every house in the square. In the larger squares, these green plots are planted with groups of trees; and in the smaller ones with clumps of flowering bushes and shrubs, often interspersed with trees. By this arrangement, these quadrangles, and the houses which surround them, have quite a rural and romantic appearance. According to the capabilities of the situation, these plots are sometimes square, sometimes oval or circular; and they are railed in with a light tasteful palisade which does not injure the prospect. Where the streets are very wide, there is in front of every house a small garden, fenced in front, and generally containing a small green, and some tufts of elegant shrubs or beautiful flowering plants, which give to the whole street a cheerful, and to a certain degree a theatrical appearance. The houses themselves are often covered as high as the second story with *Jasmine*, *Roses* (particularly *Rosa semperflorens* and *Banksii*), with *Clematis*, *Corchorus japonicus*, *Bignonia radicans*, and the like, or entwined with them as a beautiful garland. *Camellias* (?), *Rhododendrons*, and *Dahlias*, usually form the clumps on the green places before the houses, which are no where seen in such perfection as in England; for the beauty of these verdant lawns, which extend in front of the dwellings like a green velvet carpet, has often attracted my attention; and I have inquired of several gardeners the names of the particular species of grass employed for this purpose. *Agrostis alba*, *verticillata*, and *stolonifera*, *Poa pratensis*, *Lolium perenne*, and *Festuca pratensis*, have all been indifferently named: almost every person has mentioned some other kind than has been recommended by my former informants; but all agree in this, that these grass plots require to be mown carefully every fortnight,—some say even every week,—with the scythe; in fact, to be close shaven. To the great frequency with which the grass is cut, the beauty of these lawns, or bowling-greens, seems to be chiefly owing; their fine preservation is also aided by the mild and equable climate

of England, where the winters are never so severe as to check vegetation for any long period, nor the summers so scorching as to burn up the tender roots; while the frequent fogs and constantly damp state of the atmosphere morning and evening are highly favourable to verdure. Were the lawns in our country to be mown so often and so close, they would infallibly be soon burnt up. The opulent Englishman is so partial to a garden, that if his house should chance to have a northern exposure where not a ray of sun can reach, he will yet plant it with evergreen shrubs, as the *Ilex;* and with such flowers as are found capable of enduring such an aspect. It is the general taste that prevails for plants, to which the number of nursery-grounds, and the astonishingly active business that they carry on, are owing. The success of so many *marchands des plantes* continually encourages their increase; and I am told that not a year passes without the establishment of some new institution of this kind. On the way to Hammersmith to see Kennedy and Lee's Nursery, we met the proprietors of two others, Gray and Sons, and Malcolm and Co. at Kensington. The house of Lee and Kennedy, so well known with us on the continent, has lately experienced great changes. Mr. Kennedy has withdrawn from the concern, and is gone to Amiens in France; and the old Lee died about two months ago. At present, the sons carry on the management of this large nursery, which they themselves say contains one hundred acres, and requires the labour of from one hundred and fifty to two hundred workmen. Although this estimate seems to me enormously large, yet thus much is certain, that it is one of the greatest nurseries in London, and carries on an extensive trade both at home and abroad. The more common kinds of plants seem to be chiefly cultivated here; although there are three hundred species of *Erica*, and half of every day is allotted to the management of *Camellias*. The stoves are of the usual kind: there is no pond for the convenient watering of the plants; nor have the proprietors published a new Catalogue.

Mr. Colville, on the road to Chelsea, certainly has the rarer kinds of plants in his collection. Messrs. Mackay and Co., Fraser, &c. have also gardens in this neighbourhood. We here became acquainted with Mr. Sweet, whose publications on the *Gerania* and *Hortus Suburbanus* are well known. Many unknown and rare vegetables from all parts of the world, particularly Nepaul, New Holland, and New Zealand, and the tolerably well explored Cape of Good Hope, exist in Mr. Colville's Nursery: but the establishment of this kind, which belongs to Mr. Conrad Loddiges, appeared to us the largest and finest in England. It would be hard to say whether its great

extent,

extent, the beautiful productions with which it is stocked, or the judgement, taste, and liberality with which it is conducted, are most worthy of admiration. With regard to the latter point, we will venture to say, that much as we have travelled and seen, we have met with no stoves, belonging to prince, king, or emperor, which can compare with those of Messrs. Loddiges, at Hackney, for the magnificence, convenience and elegance of their plan, and the value of their contents. Let my reader imagine a dome, eighty feet long and forty feet high, built in the form of a paraboloid, purely of glass, kept together by a delicate but strong frame of small iron ribs. This dome is heated by steam, when the rays of the sun are found insufficient to warm it. In ascending to the upper part of it by an elegant stage thirty feet high, we thence enjoy a scene entirely novel to a native of Europe: the tropical plants of both hemispheres, the eastern and the western, are stretched below at our feet; and the prospect is similar to what might be presented on a hill clothed with tropical verdure, through an opening in which we might look at the scenery beyond. A slight touch with one finger suffices to bring down from the light roof of this dome a fine shower of rain, which sprinkles all the exotic vegetation among which you walk. To this gentle and careful manner of watering the plants, (the nearest mode of imitating nature,) may be ascribed the rich luxuriance of the inmates of this stove. Besides this house, there are some twenty others, from one hundred and fifty to three hundred feet long, and greenhouses of various dimensions; all situated in two large gardens, containing about one hundred acres, divided by a wall, in which plantations are scattered. One of the houses, built after the newest plan with convex windows, is stocked with nearly four hundred kinds of Heath. I am spared the task of enumerating the rarities of this garden, by the 13th edition of its Catalogue, published in 1823; and the pretty work called the Botanical Cabinet, which appears regularly.— As we were walking in the garden, through ranges of *Camellia*, *Rhododendron*, *Azalea*, &c. accompanied by one of the sons of Mr. Loddiges, we took the liberty of asking him what might be the value of the plants in the whole collection, supposing that every one in the Catalogue were sold according to its price as there marked? "About 200,000*l.*" was the reply: that is 2,800,000 florins. The cultivation of gardens cannot therefore be so paltry an occupation as some individuals at the University of Landshut would have us to believe, who, while they will spend 6000 florins in a beer cellar, yet allow the botanical garden there, which might serve as a nursery-ground for the whole country, to fall to decay in

a manner

a manner as useless as it is mean; and this too, when the gardens of the other Universities of Germany have been lately doubled and trebled in extent. As President of the Botanical Garden at Landshut, it becomes me thus publicly to declare this matter, in order that the disgrace which must accrue to the University, which is so far behind her German sisters, may not fall upon me, but on those who, contrary to the wishes of those wise promoters of good,—the Bavarian government,—have brought this stain upon Landshut, and whose names will be pronounced by posterity with the contempt they deserve. Let us only consider what a multitude of people are employed and maintained in London alone by these nurseries: not in labouring the ground and tending the plants only, but in making the millions of pots, of which the smallest costs a halfpenny (a groschen of our money); in manufacturing the immense quantity of glass which is used; in executing the smiths' and carpenters' work;—and it must then be readily confessed, that the improvement of a people has attained a high pitch, when the most pure, noble, and innocent kind of pleasure and taste, namely the enjoyment of the beauties of vegetation, has become a necessary; and thereby bestows food, clothing, and comfort on thousands of individuals, who must otherwise be a burthen to society. The nurserymen of London, from their great business, several of which annually return half a million, are obliged to have counting-houses of their own. Many of them keep travelling botanists in their pay, who from the most remote parts of the globe must send them seeds, roots, and living plants. In China, the East Indies, the Cape of Good Hope, at Sierra Leone, New Holland, New Zealand, Paraguay, Chili, Mexico, and the most northern parts of America and Siberia, many of these enterprising individuals have collectors; so that Geography is often improved by the trade of horticulture. How reprehensible therefore is the conduct of those who,—instead of promoting the culture of gardens and the love of plants, by which, according to the immortal Bacon, the mind and heart are alike improved,—endeavour to suppress and stifle all industry; and whilst they instruct youth in such detestable maxims, as that "sin alone is the road to God," (!) corrupt the rich and demoralize the poor. In Bavaria we have only one great person who possesses a garden that deserves the name (except that at Irlbach); and this nobler personage than Bavaria ever numbered among her *magnates*, is also the friend of that first ruler of Bavaria under whose happy government Botany and Horticulture began to be known. Is it not mortifying to behold the nurserymen of England displaying more taste and wealth than our nobility?

Perhaps

Perhaps I shall be answered, "It is only possible in England; only the natives of that opulent isle could do so!"—I beg pardon: Mr. Loddiges, the celebrated gardener and botanist, is no Englishman; he is—a German, a Hanoverian. In his youth he came over to this country as a gardener, possessing no other fortune than industry, talent and worth; and he is now an old man of eighty-six; a *millionnaire*, the father of many hundred English citizens (!), who for almost half a century have afforded to others the maintenance, without which they might have starved. He has the felicity of seeing two of his sons grown up, and very much like him; and grandsons who promise to be so too. His name will shine conspicuous in the annals of British Horticulture, and be pronounced with respect by all who honour virtue and good sense. The respectable old Loddiges strongly reminded both my son and myself of my immortal friend the late Bertuch of Weimar.

I have asked of many, I may say of very many Englishmen, why the great island in the west, called Ireland, is less known with respect to its botany, than Canada, Greenland, and Iceland. From all of whom I have received, instead of an answer, the remark, "That is a land of ——." Also I am assured that "it is safer to travel among savages than in the west coast of Ireland, where one is pestered by the Catholic clergy, and in momentary danger of being knocked down by the slaves." The exasperation of the English against the Irish is truly excessive, and can never be removed while so many causes of irritation remain. It appears to me that the blackguards must set the good neighbours together by the ears; and this *coursing*, as they say in England, will be kept up from the east and from the north-east with gold and silver "tam-tams" (?). There are two large islands in Europe, of whose Flora we are totally ignorant;—one is Sardinia, the other Ireland: both belong to the *Infallible* Church: had they belonged to the other, we had long ere now been furnished with a history of their vegetable productions; for all botanists have hitherto been members of the *Fallible* Church.

Since writing the above remark,—that Ireland and Sardinia are still *terræ prorsus incognitæ* in the European Flora,—I have received a letter from the very excellent Balbis, of Lyons, in which he informs me that his friend and former student, the active Bertero, has received orders from the Royal Sardinian Government to explore, with a botanical view, that hitherto unknown island, and to compile a Flora of it. He will be provided with all necessary assistance at the public expense: and thus we shall become acquainted with the vegetation of Sardinia, as we are with that of Sicily and Corsica. Much may

be

be expected from the energy and zeal of the indefatigable Bertero.

I can also give you a piece of botanical intelligence from Paris. The celebrated Baron Bory de St. Vincent will in the course of this year proceed to the Antilles; there to examine that favourite tribe, the *Ferns*, of which he already possesses a very complete collection. He expects to be able to elucidate all the points which Plumier left doubtful. From the well-known liberality of mind which this enlightened naturalist possesses, I should hope that it would be as agreeable to him as to our Germans who are partial to the Ferns, to have this information communicated in these pages; and, whether before or after his voyage has taken place, to see them thus placed in connection will confer much pleasure on

J. A. Schultes.

LXVIII. *Sketch of a Classification of the European Rocks.* By Henry T. De la Beche, *Esq. F.R.S, &c.**

To propose in the present state of geological science any classification of rocks which should pretend to more than temporary utility, would be to assume a more intimate acquaintance with the earth's crust than we possess. Our knowledge of this structure is in reality but small, and principally confined to certain portions of Europe; and even in many of these portions we are continually presented with new views and a detail of newly-discovered phænomena by able observers, which so modify our previously received opinions as in many instances almost to amount to a change of them. Still, however, a large mass of information has been gradually collected, particularly as respects this quarter of the world, tending to certain general and important conclusions; among which the principal are,—that rocks may be divided into two great classes, the stratified and the unstratified;—that of the former some contain organic remains, and others do not;—and that the non-fossiliferous stratified rocks, as a mass, occupy an inferior place to the fossiliferous† strata, also taken as a mass. The next important conclusion is, that among the stratified fossiliferous rocks there is a certain order of superposition, marked by peculiar general accumulations of organic remains, though the mineralogical character varies materially. It has even been supposed that in the divisions termed formations, there are found certain species of shells, &c. characteristic of each. Of this

* Communicated by the Author.

† The term *fossiliferous* is here confined to organic remains.

this supposition, extended observation can alone prove the truth; and in order properly to investigate the subject, geologists must agree to what mass of rocks they should limit the term Formation: if, as some now do, they apply it to every accumulation of ten or twenty beds, which may happen, in the district they have examined, to contain a few shells not found in the strata above and beneath, the investigation is not likely to lead to any extended conclusions.

To suppose that all the formations into which it has been thought advisable to divide European rocks can be detected by the same organic remains in various distant points of the globe, is to assume that the vegetables and animals distributed over the surface of the world were always the same at the same time, and that they were all destroyed at the same moment to be replaced by a new creation, differing specifically if not generically from that which immediately preceded. This theory would also infer that the whole surface of the world possessed an uniform temperature at the same given epoch.

It has been considered, but yet remains to be proved, that the lowest fossiliferous rocks correspond generally in their fossil contents, in places far distant from each other. Let us for the moment suppose this assertion to be correct. To obtain this uniform distribution of animal and vegetable life, it seems necessary, judging from the phænomena we now witness, that there should also have been an uniform temperature over the surface of our planet. To obtain this, solar influence, as it now exists, would be inadequate; we must therefore have recourse to internal heat to produce the effect required. In the present varied temperature of the earth's surface, if we imagine a rock to be formed which should envelop every animal and plant now existing, the fossil contents of one district would differ from the fossil contents of another; if we except man, whose bones would more or less become the characteristic fossils of those portions of the rock which might overlie the present dry land. The rock supposed to be now formed would present a striking contrast with the old fossiliferous, and we should have two very distinct accumulations of organic remains. The question arising on such phænomena would be, Has so great a change of organic character been effected gradually or suddenly? To suppose it sudden will not agree with the phænomena presented to us, even by the now known European rocks; and if it be considered gradual, we cannot expect that rocks should every where contain the same organic remains, even in those that have been commonly called secondary: consequently the organic remains considered characteristic of any

particular formation in one part of the world, may not be found at all in an equivalent formation in another.

Upon the theory that the world cooled in such a manner that solar heat, as now existing, gradually acquired its influence, the warm climate vegetation would gradually be restrained within narrower limits, until it became circumscribed as it now is; consequently all rocks formed within the tropics would probably contain warm climate plants, while these would gradually cease on the N. and S.; so that it would be by no means safe to deduce the kind of Flora that should be found in any given rock in the tropics from the fossil plants discovered in an equivalent rock in Europe. If vegetable life might under such circumstances so vary, there seems no good reason why animal life might not equally differ. To what extent the mass of organic fossils found in any particular European formation or group of formations may exist in equivalent rocks (of Africa or America for instance), remains to be seen. In the present state of our knowledge, it is only safe to state that certain remains have been discovered in a given rock, not that they are absent from it.

The old divisions into primitive, transition, secondary, and tertiary, are now admitted by many persons to be founded on an erroneous view of nature; yet such is the force of habit, that many geologists, aware of the fallacy of these divisions, still continue to use the terms, and we hear nearly as much as ever of transition rocks. Would it not be imagined by a person first directing his attention to the study of geology, that there were three great marked periods, during each of which rocks of a peculiar character, distinct from each other, were formed, and that there was a transition or passage only between the first and second of these. I appeal to those who have examined rocks in the field, and not merely in cabinets and museums, whether or not the student would entertain correct opinions. These divisions may be said to have been made in the infancy of the science, and doubtless contributed much to its present comparatively advanced state; but it should always be recollected that they were formed from limited observations, and were connected with particular theories, which recent and more accurate observations have shown to be any thing but correct. If it shall be proved that there is an occasional passage between the old tertiary and secondary classes, there would appear to be more or less transition throughout the whole series of the stratified rocks, showing that the term transition, at least, is incorrect. A great mass of evidence is, indeed, in favour of a break at the

the epoch of the Exeter Red Conglomerate (*Rothe Todte Liegende*), resulting from a great derangement in the previously existing rocks, and the grinding and rounding of detached portions of them into gravels, which when comparative tranquillity was restored, were deposited in horizontal beds on the disturbed strata. Yet able observers assert, that there is an occasional passage of these rocks into the coal-measures, upon which they so commonly rest in an unconformable manner. We have now so many instances of great differences in the mineralogical structure of the same formations, either original or consequent on disturbance, that such structure is no longer a character of importance; and it yet remains to be seen how many of the strata supposed to belong to the primitive class are altered rocks.

M. Brongniart's division into "Sediment Rocks" would be both natural and useful were it certain where such rocks commenced, and that all those necessarily included in the class were so formed. This division has been much used in France of late, and would appear infinitely superior to the terms secondary and tertiary.

In offering the annexed sketch of a classification of European rocks to the attention of the reader, it is merely my intention to show that divisions can be made for practical purposes, independent of the theoretical terms primitive, transition, secondary and tertiary; terms which not being founded on an enlarged view of nature, but grounded on peculiar views, now doubted, there would appear no good reason for preserving. It is not presumed that this classification will be adopted, and I am well aware that many just objections can be made to it; but it pretends to nothing beyond convenience: and if geologists could be induced to use something of this kind, or any other that would better answer the purpose of relieving us from the old theoretical terms, I cannot but imagine that the science would derive benefit from the change.

In the accompanying Table, rocks are first divided into stratified and unstratified, a natural division, or at all events one convenient for practical purposes, independent of the theoretical opinions that may be connected with each of these two great classes of rocks. The same may perhaps also be said of the next great division; viz. that of the stratified rocks into superior or fossiliferous, and inferior or non-fossiliferous. The superior stratified or fossiliferous rocks are divided into groups, nearly the same as those which I published in the *Annales des Sciences Naturelles* for August last. I have myself found them useful in practice, more particularly in the examination of districts distant from each other.

 STRATI-

STRATIFIED ROCKS.—Group 1. (*Alluvial*) seems at first sight natural and easily determined; but in practice it is often very difficult to say where it commences. When we take into consideration the great depth of many ravines and gorges which appear to originate in the cutting power of existing rivers, the cliffs even of the hardest rocks which more or less bound any extent of coast, and the immense accumulations of comparatively modern land, as for instance, those great flats on the western side of South America, there is a difficulty in referring these phænomena to the duration of a comparatively short period of time. Geologically speaking, the epoch is recent; but, according to our general ideas of time, it appears to be one that reaches back far beyond the dates usually assigned to the present order of things. Man and the monkey tribe seem to be the most marked new creation of this epoch. I would by no means be supposed to deny that they may not have previously existed, but at present the mass of evidence is against their prior appearance. There seems, indeed, no good reason why man and the monkeys should not have lived as well as the bears and hyænas at periods antecedent to this epoch; but until the remains of the two former be found in rocks proved to be formed previous to this period, it cannot be affirmed that they did*. The animals now existing, considered as a mass, appear to differ specifically from those whose remains are found entombed in the various rocks, gravels, clays, &c. formed previously to the existing order of things. There are indeed a few exceptions to this observation, but the body of evidence seems to render a new creation presumable.

Group 2. (*Diluvial*) comprises those gravels so commonly occurring in situations where actual causes could not have placed them, but where, on the contrary, such causes tend to destroy them. The most extraordinary feature of this group is the distribution of those enormous blocks or boulders found so singularly perched on mountains, or scattered over plains far distant from the rocks from whence they appear to have been broken. Many valleys appear to have been scooped out of horizontal or nearly horizontal strata at this epoch; the force which excavated them having acted often upon strata shat-

* Should such observations as those lately made on the caverns of the department of the Gard by M. de Christol (*Annales des Mines* 1829) be multiplied, and should it be always shown that human bones and pottery are, as is stated to be the case, in these caverns, really of the same date as the hyæna's bones, dung, &c. with which they are mixed,—we can scarcely refuse to admit that man existed previous to the alluvial epoch; supposing it in all cases proved that these cavern remains are of the same date as those considered of the diluvial period.

tered

tered and broken into faults. Of course a general modification of the previously existing forms of mountain and valley must have taken place, if we are to consider the catastrophe general. Much information is yet wanting respecting this group, which it is hoped those observers who have been more especially occupied with it, will soon afford us.

Group 3. (*Lowest Great Mammiferous*) comprises the rocks commonly known as tertiary: they are exceedingly various, and contain an immense accumulation of organic remains, terrestrial, fresh-water, and marine. The recent observations of some able geologists have shown that the upper members of this group approach more closely than was formerly supposed to the existing order of things. We yet require much information respecting even the European rocks composing this class, notwithstanding the labours of those who may almost be said to have devoted their exclusive attention to them. The group is characterized by the first appearance, in the ascending series, of any abundance of the mammiferous animals, many genera of which are now extinct.

Group 4. (*Cretaceous*) contains the rocks which in England and the North of France are characterized by chalk in the upper part, and sands and sandstones in the lower. The term "cretaceous" is perhaps an indifferent one; for, possibly, the mineralogical character of the upper portion whence the name is derived is local, that is, confined to a particular portion of Europe, and may be represented elsewhere by dark compact limestones or even sandstones. As however the geologists of the present day are perfectly agreed as to what rock is meant when we speak of "the chalk," there seems no objection to retain it for the present. The French geologists have long considered the sands beneath the chalk, known as green-sands, as belonging to the same formation with the chalk. That the fresh-water character of the shells contained in the Wealden rocks is more or less local it seems but rational to infer; for it cannot be imagined that all the waters of the globe became suddenly fresh in order that these rocks might be formed, and as suddenly salt again for the deposition of the green-sands and chalk. Some French geologists moreover consider that in France there is a marine equivalent of the Wealden rocks.

As far as our observations of fossil organic remains have yet extended, it would seem probable that the ammonites and belemnites ceased to exist after the formation of this group; for, as yet, their remains have not been detected in Group 3. Should this, after a greater extent of the world has been examined, be found generally true, it will be a most valuable guide

in

in determining the relative ages of this and the previously noticed group in cases where the mineralogical structure is of no avail.

Group 5. (*Oolitic*) comprises the various members of the oolite or Jura limestone formation, including lias. The term oolitic has been retained upon the same principle as that of cretaceous: in point of fact even in England and the North of France the oolites, properly so called, form but an insignificant part of the mass of rocks known by the name of the oolite formation; this character is also not confined to the rocks in question, but is common to many others. In the Alps and Italy the oolite formation is replaced by dark and compact marble limestones, so that its mineralogical structure is of no value. Saurians would appear to have been abundant in some places. The prevailing fossil characteristic seems the extraordinary quantity of ammonites and belemnites, the remains of which are so numerous in this group. It is remarkable that the nautilus should have been continued down to the present time, and that the other camerated shells which swarmed at this epoch should not now be found. The belemnites do not appear to occur beneath the lias, at least as yet we have no well authenticated instance of such occurrence.

Group 6. (*Red Sandstone*) contains the variegated marls (*Marnes irisées, Keuper*) the Muschelkalk, the New Red Sandstone (*Grès Bigarré, Bunter Sandstein*), the Zechstein, and the Exeter Red Conglomerate (*Rothe Todte Liegende*). The whole is considered as a mass of conglomerates, sandstones, and marls, generally of a red colour, but most frequently variegated in the upper parts. The limestones may be considered subordinate. Sometimes only one occurs, sometimes the other, and sometimes both are wanting. There seems no good reason for supposing that other limestones may not be developed in this group in other parts of the world. When the muschelkalk is very compact with broken stems of the *lily encrinite* *, one of its characteristic fossils, it might easily be mistaken for some of the varieties of the carboniferous limestone. In some places the new red sandstone contains an abundance of vegetable remains, at others none can be detected in it. The saurians first appear in the ascending series, at least in any abundance, in this group. As I have before observed, the lower part of this group generally rests unconformably on the inferior rocks, and seems to have resulted from a very general upheaving and fracture of the preexisting strata, accompanied by the intrusion of trap rocks.

* Encrinites moniliformis. *Miller*.

Group

Group 7. (*Carboniferous*) Coal-measures and carboniferous limestone. The former would appear in the greater number of instances to be naturally divided from the group above it, but the latter would seem more allied to that beneath: there is however so much connection in this country between the coal-measures and the carboniferous limestone, that it would appear convenient for the present to keep them together. Judging from Europe, the coal-measures present us with the largest mass of fossil vegetables.

Corals were common, but they occur in as great abundance, if not more plentifully, now; though the recent species, generally speaking, differ from the fossils. But Productæ, the abundance of which characterizes this group, are now unknown; and the Crinoidea which occur in these rocks in multitudes are very rarely found in a living state.

Group 8. (*Grauwacke*) This may be considered as a mass of sandstones, slates and limestones, in which sometimes one predominates, sometimes the other; the old red sandstones of the English geologists being the upper of its sandstones. Trilobites are the most remarkable and abundant fossils of this epoch, and corals and orthoceratites occur in great numbers. It is difficult to fix the inferior limits of this group.

Group 9. (*Lowest Fossiliferous*) It is very difficult in the present state of our knowledge to say whether or not this constitutes a separate group from No. 8; and I have here introduced it more in accordance with the views of other geologists than with my own. A difference in mineralogical structure proves nothing; the changes in this respect are so various, that the different appearance of one slate from another, if not shown to occupy a different geological position, is of no value. It has indeed been supposed that the Snowdonian slates are older than the grauwacke series, but we yet require the proof of this.

Inferior or Non-fossiliferous Stratified Rocks.—It would be useless in a sketch of this nature to enumerate the varieties of slates and other rocks that enter into this division, they will readily present themselves to the mind of the geologist; recent observations show that many rocks to all appearance of this division may belong to the preceding. M. Elie de Beaumont, in one of his late letters to me, states, that mounting the Val Bedretto from Airolo to the foot of the Col, which leads into the Haut Vallais, he found "an alternation many times repeated of small beds of a compact and grey-black limestone, and a nearly black limestone mixed with clay slate thickly studded with crystals of garnets and staurotides. Both the one

one and the other of these rocks contain a considerable number of belemnites transformed into white calcareous spar, but of which the general forms and alveoli are nevertheless very visible, and can leave no doubt as to the nature of the fossils. As these limestone beds are the prolongation of those in which the gypsum of the Val Canaria is found, and as these are the same with those in which the dolomite of Campo Longo occurs, we can assure ourselves that all the curious mineralogical phænomena of the St. Gothard have been introduced into beds contemporaneous either with the oolite series or the greensand." Now when such important changes as those noticed by my friend M. Elie de Beaumont can be fairly traced, what may we not expect to find in the sequel, when geologists shall cease to be contented with referring a particular mineralogical structure to the old divisions transition and primitive, of which the former seems only to have been created as a geological trap.

Unstratified Rocks.—This great natural division is one of considerable importance in the history of our globe. To the rocks composing it, and the forces which threw them up, may be attributed the dislocations and fractures in the stratified rocks every where so common, and in many instances their elevations into lofty mountain ranges. In many of the great chains the trap rocks are visible along their line of elevation, as was first observed by M. Von Buch in the Alps,—on the southern side of which they are exposed at intervals; and it is on this side that there is so much dolomite in the limestones. To assert that igneous rocks cannot be present along the whole of this line because not every where visible on the surface, is like affirming that there is no table beneath a cloth spread on it except in the cases where there may be a few holes. We are too apt in judging of the mass and thickness of rocks to compare them with our own size, and imagine them enormous, expressing surprise at the immense forces which it must have required to raise such masses into mountains; when if they were compared, as they ought to be, with the mass of the world, the thickness becomes trifling, the highest mountains insignificant, and the forces required to raise them comparatively small.

That granitic, trappean, and serpentinous rocks have exercised a great influence on the present position of the stratified rocks, few geologists will doubt. The igneous origin of the two former is also very generally admitted; but though the third is not so generally referred to that origin, I know not how we can deny that it was produced by a cause somewhat similar

similar to that which produced the others, when we consider its mode of occurrence, more particularly in the Alps and in Italy.

The geological dates of the elevations of mountains is a most important subject, and one on which M. Elie de Beaumont read a very interesting paper, in June last, before the Institute of France*. His recent observations have tended to confirm his previous remarks on four of these epochs. 1st. That the Ezgeberge, the Cote d'Or, &c. have been elevated between the epoch of the Jura limestone and the green-sand and chalk. (Groups 5 and 4 of the annexed Table.) 2nd. That the Pyrenees and Apennines were thrown up between the epoch of the chalk and tertiary rocks (Groups 4 and 3). 3rd. That the Western Alps were raised between the tertiary epoch and the first "terrains de transport" (Groups 3 and 2). 4th. That still later, there was an elevation of mountains, in which were comprised some in Provençe, the Central Alps, &c.

How far the igneous rocks have been connected with these phænomena remains to be seen; but, as before stated, it is by no means fair to infer that because not seen on the surface they do not exist beneath. Volcanoes, properly so called, both existing and extinct, seem to have exerted a minor influence in the elevation of strata compared with that exerted by the igneous rocks which were shot up previous to the action of these volcanoes. Elevations of land do however take place apparently from the causes that produce volcanoes; and of these the rise of land noticed in Chili by Mrs. Maria Graham, in consequence of the earthquake of 1824, is a striking example.

Should the annexed Table succeed in calling the attention of geologists to other divisions than those made in the infancy of the science, and grounded on particular theories, one supposing three great epochs and a transition between the first and second of these, another considering rocks divisible into two great classes, a primary and secondary, the primary containing organic remains in its upper part,—my object will, as I before stated, be fully answered. We are yet acquainted with so small a portion of the real structure of the earth's exposed surface, that all general classifications of rocks are premature; and it seems useless to attempt any others than those which are comparatively local, calculated for temporary purposes, and of such a nature as not to impede by an assumption of more knowledge than we possess, the general advancement of geology.

* The first part of this paper has been published in the *Annales des Sciences Naturelles* for September.

CLAS-

Classification of European Rocks.

Stratified Rocks	Superior Stratified, or Fossiliferous.	1. Alluvial Group .	Detritus of various kinds produced by actual causes. Coral Islands. Stalagmitical incrustations. Peat bogs. &c.	Probable appearance of Man and the Monkey Tribe, according to existing information.
		2. Diluvial Group .	Transported boulders and blocks; gravels on mountains, hills, and plains, which actual causes tend to destroy.	Valleys cut in previously horizontal, or cracked strata; modification of the anterior forms of mountain and valley.
		3. Lowest Great Mammiferous .	The various rocks known as tertiary; characterized by a great abundance of terrestrial, marine, and fresh-water remains, some of which approach, and others resemble, those now existing.	First appearance of any abundance of mammiferous animals in the ascending series.
		4. Cretaceous Group	Chalk, green-sand, and Wealden rocks; the latter perhaps a local variety of a marine formation.	Last appearance, in the ascending series, of Ammonites and Belemnites.
		5. Oolitic Group . .	Rocks usually known as the Jura limestone or oolite formation, including lias.	Great abundance of Ammonites and Belemnites; last appearance of belemnites in the descending series.
		6. Red Sandstone Group . . .	Variegated marls (*Marnes Irisées Keuper*), Muschelkalk, New Red Sandstone (*Grès Bigarré, Bunter Sandstein*), Zechstein, Exeter Red Conglomerate (*Grès Rouge, Rothe Todte Liegende*).	First appearance, in any abundance, of Saurians in the ascending series.
		7. Carboniferous Group . . .	Coal Measures. Carboniferous limestone.	Abundance of vegetable remains, Encrinites and Productæ common in the limestone.
		8. Grauwacke Group	Old Red Sandstone, Grauwacke, Grauwacke limestones, Grauwacke clay slates.	Trilobites common.
		9. Lowest Fossiliferous Group .	Snowdonian Slates. Tintagel Slates, &c.	Organic remains rare.
	Inferior Stratified, or Non-fossiliferous.	No determinate order of superposition	Talcose Slate. Clay Slate. Flinty Slate. Micaceous Slate. Gneiss, &c. &c.	It would seem that the superior stratified may, from various circumstances, assume the appearance of the inferior stratified rocks.
Unstratified Rocks. .		1. Volcanic Group .	Ancient and Modern lavas, Trachyte, Basalt, &c.	The trappean and granitic rocks so pass into each other, that they can often be considered only as modifications of the same substances.
		2. Trappean Group .	Greenstone, Basalt, Porphyry, Amygdaloïd, &c.	
		3. Serpentinous Group	Serpentine, Diallage Rock.	
		4. Granitic Group .	Granite, Syenite, Porphyry, &c.	

LXIX. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones.* *By* J. G. CHILDREN, *F.R.S. L. & E. F.L.S. &c.*

[Concluded from page 335.]

Genus 96. AMPHIDASIS, *Ochs., Treitsch.*

(AMPHIDASIS, PHIGALIA, NYSSIA, Duponchel.)
AMPHIDASIS, BISTON, Stephens.

Antennæ bipectinated in the males, simple in the females; the apex sometimes naked.—*Wings* strong, generally of a whitish-gray colour, with dark, indistinct bands, and coarse dots; females occasionally apterous.—*Body* short, and pointed in the males; in the females stout, conical: *thorax* broad, hairy.

Species.	Icon.
1. Amp. *Betularia*, Linn.* †	Hübn. Geom. tab. 33. f. 173. (fœm.)
2. — *Prodromaria*, Fab.* †	Hübn. Geom. tab. 33. f. 172. (mas.)
3. — *Hirtaria*, Linn.* †	Hübn. Geom. tab. 33. f. 175. (mas.)
4. — *Pilosaria*, Hübn.‡ § ...	Hübn. Geom. tab. 34. f. 176. (mas.)

* BISTON, Stephens.

† AMPHIDASIS, Duponchel.—"*Antennæ* pectinated in the males, simple in the females. Terminal margin of the *wings* simple or entire.—*Thorax* broad, woolly.—*Wings* thick and small in proportion to the body.—*Head* sunk beneath the thorax.—*Abdomen* large, conical.—*Maxillæ* none, or scarcely discernible.—*Females* winged.—*Larva* long, cylindrical, tubercular; *head* flat, more or less emarginate on the upper part.—*Pupa* naked, in the earth."—*Duponchel, Lep. de France, tom.* vii. *part.* ii. p. 268. Except that the larvæ are decided *loopers*, the three species included in this genus by M. Duponchel, might be taken for Bombyces, which, in their perfect state, they very much resemble; they differ from them, however, by the antennæ of the females being entirely filiform, whereas in the Bombyces they are always slightly pectinated, or ciliated.

‡ AMPHIDASIS, Stephens.

§ PHIGALIA, Duponchel.—"*Antennæ* pectinated in the males, ciliated in the females.—Terminal margin of the *wings* simple.—*Thorax* broad, woolly. *Abdomen* slender.—*Wings* thin, and large in proportion to the body.—*Palpi* velvety, not projecting beyond the forehead.—*Maxillæ* none, or scarcely discernible.—*Females* apterous.—*Larva* cylindrical, of equal size throughout, with a few short hairs; *head* hemispherical; a bifid tubercle on the eleventh segment.—*Pupa* naked, in the earth."—*Duponch. l. c.* p. 296. Duponchel has formed this genus on the single species, *pilosaria*, which differs from his Amphidases and Nyssiæ, by its slender abdomen, and proportionately wider and thinner wings; and also from the former by the female being apterous.

Species.	Icon.
5. Amp. *Alpinaria*, Hübn.*	Hübn. Geom. tab. 34. f. 178. (mas.) tab. 99. f. 513. (fœm.)
6. —*Hispidaria*, Fab.† * ...	Hübn. Geom. tab. 34. f. 177. (mas.)
7. —*Pomonaria*, Hübn.† ...	Hübn. Geom. tab. 34. f. 180. (mas.)
8. —*Zonaria*, Hübn.†	Hübn. Geom. tab. 34. f. 179. (mas.) tab. 99. f. 511. (fœm.)

Genus 97. PSODOS, *Ochs., Treitsch.*

(PSODOS, Duponchel. PSYCOPHORA, Kirby, Stephens.)

Palpi very hairy, projecting beyond the forehead.—*Maxillæ* long. Ground-colour of the *wings* and *body* black, or very dark; the latter slightly hairy, and slender.

Species.	Icon.
1. Pso. *Alpinata*, Hübn.‡ §	Hübn. Geom. tab. 38. f. 197. (mas.)
2. —*Torvaria*, Hübn.	Hübn. Geom. tab. 71. f. 366. 367. (mas.) 368. 369. (fœm.)
3. —*Horridaria*, Fab.	Hübn. Geom. tab. 60. f. 312. (fœm.)
4. —*Venctaria*, Hübn.	Hübn. Geom. tab. 64. f. 329. (mas.)
5. —*Trepidaria*, Hübn.§ ...	Hübn. Geom. tab. 66. f. 343. (fœm.)

Genus 98. FIDONIA, *Ochs., Treitsch.*

(FIDONIA, LIGIA, STRENIA, HALIA, NUMERARIA, HIBERNIA, Duponchel.

FIDONIA, BUPALUS, ANISOPTERYX, LAMPETIA, GRAMMATOPHORA, AZINEPHORA, CHEIMATOBIA, HERCYNA, HYRIA, Stephens.

BUPALUS, SPERANZA, Curtis.

Wings entire, rounded; sprinkled with dark, minute specks, like dust.—*Body* slender; back narrow.—*Larva* stout in proportion to its length, with generally bright coloured dorsal and lateral stripes.—*Metamorphosis* in a thin web, on the ground, or at a small depth below the surface.

* NYSSIA, Duponchel.—"*Antennæ* pectinated in the males, simple in the females.—Terminal margin of the *wings* simple.—*Thorax* broad, woolly.—*Wings* thick and small in proportion to the body.—*Head* sunk beneath the thorax.—*Abdomen* large, conical.—*Palpi* velvety, not projecting beyond the forehead.—*Maxillæ* wholly, or nearly wanting.—*Females* apterous.—*Larva* cylindrical, slightly attenuated at each end, sometimes smooth, sometimes with little tubercles, each carrying a single hair; *head* hemispherical.—*Pupa* naked, in the earth."—*Duponch. l. c.* p. 283. The Nyssiæ are distinguished from the Amphidases (which they very much resemble), not only by the females being apterous, but also by the hemispherical head of the larvæ, which live also exclusively on trees; whereas the larvæ of the latter feed, apparently, in preference on herbaceous plants.

† AMPHIDASIS, Stephens. ‡ PSODOS *equestrata*, Duponchel.

§ PSYCOPHORA, Stephens.

1. Fid.

Species. Icon.

1.Fid.*Cebraria*, Hübn......Hübn.Geom. tab.24. f. 129. (mas.)
2.—*Hepararia*, Hübn......Hübn. Geom. tab. 11. f. 58. (mas.)
3.—*Pinetaria*, Hübn.......Hübn.Geom. tab.24. f.130. (fœm.) tab. 100. f. 516. 517. (mas.)
4.—*Auroraria*, Hübn.*....Hübn. Geom. tab. 12. f. 63. (mas.)
5.—*Indigenaria*, Treitsch. Hübn.Geom. tab.91. f.168. (fœm.)
6.—*Spartiaria*, Hübn......Hübn.Geom. tab. 22. f.116. (mas.)
7.—*Conspicuaria*, Hübn.† Hübn. Geom. tab. 22. f. 117. 118. (mas.)
8.—*Piniaria*, Linn.‡.......Hübn. Geom. tab. 22. f. 119. 120. (mas.) tab. 91. f. 469. 470. (fœm.)
9.—*Diversata*, Treitsch... Hübn.Geom. tab.39. f. 202. (fœm.)
10.—*Jourdanaria*, Treitsch.§ An. de la Soc. Linn. de Paris. v. tab. xi. f. h—n.
11.—*Pennigeraria*, Hübn...Hübn.Geom. tab. 70. f.363. (mas.)
12.—*Plumistaria*, Hübn.||..Hübn. Geom. tab. 24. f. 127. (mas.)
13.—*Concordaria*, Hübn....Hübn.Geom. tab.24. f.126. (mas.) tab. 100. f. 518. 519. (fœm.)
14.—*Murinaria*, Fab........Hübn.Geom. tab. 21. f.115. (mas.) tab. 25. f. 134. (fœm.)
15.—*Atomaria*, Linn.¶......Hübn.Geom. tab. 25. f.136. (fœm.)
16.—*Glarearia*, Hübn.......Hübn.Geom. tab. 25. f.131. (mas.)
17.—*Clathrata*, Linn.[a] [b]......Hübn.Geom. tab.25. f. 132. (fœm.)

* HYRIA, Stephens.

† SPERANZA, Curtis.—*Antennæ* setaceous, with numerous oblong joints, each joint, in the males, producing two ciliated branches: simple in the females and ciliated beneath.—*Maxillæ* slender, nearly as long as the antennæ.—*Labial palpi* porrected nearly horizontally, thickly clothed with scales.—*Wings*, the superior of the male, with a small protuberance on the upper side, near the base.—*Head* small; *abdomen* slender.—*Legs* long.—*Curtis* (Extract).—Type of the genus, Sp. *sylvaria*, Curtis, Brit. Ent. v. pl. 225. (mas. et fœm.)

‡ BUPALUS, Stephens.

§ LIGIA, Duponchel.—"*Upper wings* narrow.—*Head* surmounted by a tuft of hairs terminating in a point.—*Palpi* short, obtuse.—*Maxillæ* nearly obsolete.—*Antennæ*, in the males, very plumose."—*Duponch. Lep. de Fran. tom.* vii. *part.* ii. p. 107.

|| FIDONIA, Duponchel.—"All four *wings* sprinkled with dots more or less minute, forming by their union more or less distinct bands.—*Palpi* short, often covered with long scales.—*Maxillæ* short, or obsolete.—*Antennæ* very plumose in the males of the principal species."—*Duponch. Lep. de France, tom.* vii. *l. c. supra*, p. 107.

¶ FIDONIA, Stephens.

[a] HERCYNA, Stephens,

[b] STRENIA, Duponchel.—"All four wings marked with longitudinal and transverse lines, or reticulated.—*Palpi* very short.—*Maxillæ* rather long."—*Duponch. l. c. supra*, p. 112.

18. Fid.

Species.	Icon.
18. Fid. *Dilectaria*, Hübn.....	Hübn. Geom. tab. 8. f. 39. (mas.)
19.—*Cararia*, Hübn.........	Hübn. Geom. tab. 8. f. 38. (fœm.)
20.—*Immorata*, Linn.........	Hübn. Geom. tab. 25. f. 133. (mas.)
21.—*Favillaccaria*, Hübn.*	Hübn. Geom. tab. 26. f. 139. (mas.) Curtis, Brit. Ent. i. pl. 33. ♂ et ♀.
22.—*Conspersaria*, Fab......	Hübn. Geom. tab. 26. f. 138. (mas.)
23.—*Wavaria*, Linn.† ‡......	Hübn. Geom. tab. 11. f. 55. (fœm.)
24.—*Capreolaria*, Fab.	Hübn. Geom. tab. 39. f. 204. (mas.) f. 205. (fœm.)
25.—*Plumaria*, Hübn.	Hübn. Geom. tab. 23. f. 124. (mas.)
26.—*Pulveraria*, Linn. § ‖...	Hübn. Geom. tab. 39. f. 203. (fœm.)
27.—*Aurantiaria*, Hübn. ¶..	Hübn. Geom. tab. 35. f. 184. (mas.)
28.—*Progemmaria*, Hübn. ¶	Hübn. Geom. tab. 35. f. 183. (mas.)
29.—*Defoliaria*, Linn. ¶ [a]....	Hübn. Geom. tab. 35. f. 182. (mas.) tab. 99. f. 510. (fœm.)
30.—*Aceraria*, Hübn.........	Hübn. Geom. tab. 35. f. 185. (mas.) tab. 99. f. 514. (fœm.)
31.—*Fumidaria*, Hübn......	Hübn. Geom. tab. 101. f. 520. 521. (mas.)
32.—*Bajaria*, Hübn.........	Hübn. Geom. tab. 37. f. 194. (mas.)
33.—*Leucophæaria*, Hübn. [b]	Hübn. Geom. tab. 37. f. 195. (mas.)
34.—*Æscularia*, Hübn. [b]....	Hübn. Geom. tab. 36. f. 189. (mas.)
35.—*Rupicapraria*, Hübn. [c]	Hübn. Geom. tab. 42. f. 222. (mas.)

* Bupalus, Stephens. Curtis.—"*Antennæ* setaceous, bipectinated in the males.—*Maxillæ* short, rather broad and flat.—*Labial palpi* slightly hirsute, shorter than the head, scarcely projecting beyond the eyes.—*Wings* not angular, nor indented; very much deflexed when at rest.—*Body* slender."—*Curtis. Brit. Ent.* i. pl. 33. (Extract.)

† Grammatophora, Stephens.

‡ Halia, Duponchel.—"All four *wings* pulverulent; the superior marked on the anterior margin with three or four spots, from each of which springs an indistinct line.—*Palpi* scarcely projecting beyond the forehead.—*Maxillæ* long."—*Duponch. l. c. supra*, p. 107.

§ Azinephora, Stephens.

‖ Numeria, Duponchel.—"All four *wings* pulverulent, with a transverse band on the middle of the upper.—*Palpi* acuminated, and somewhat projecting beyond the forehead.—*Maxillæ* short."—*Duponch. l. c. supra*, p. 107.

¶ Lampetia, Stephens.

[a] Hibernia, Duponchel.—"Upper *wings* more coloured than the lower.—*Palpi* very short, not projecting as far forward as the forehead.—*Maxillæ* none or obsolete.—*Legs* very long.—Females apterous, or with only the rudiments of wings."—*Duponch. l. c. supra*, p. 106.

[b] Anisopteryx, Stephens. [c] Cheimatobia, Stephens.

Genus

Genus 99. CHESIAS, *Ochs., Treitsch.*

(Chesias, Duponchel.
Chesias, Pachycnemia, Stephens.
Lobophora, Stephens, Curtis.)

Upper wings elliptical or lanceolate; *lower* oval.—*Palpi* long, depressed.—*Maxillæ* long.

Species.	Icon.
1. Ch. *Spartiata*, Fab.*	Hübn. Geom. tab. 36. f. 187. (mas.)
2.—*Polycommata*, Hübn.†	Hübn. Geom. tab. 36. f. 190. (fœm.) Curtis. Brit. Ent. ii. pl. 81.
3.—*Variata*, Hübn	Hübn. Geom. tab. 57. f. 293. (mas.) tab. 73. f. 380. (fœm.) var.
4.—*Juniperata*, Linn.	Hübn. Geom. tab. 57. f. 294. (mas.)
5.—*Obeliscata*, Hübn	Hübn. Geom. tab. 57. f. 296. (mas.)
6.—*Obliquata*, Hübn	Hübn. Geom. tab. 43. f. 225. (fœm.) tab. 82. f. 423. (mas.)
7.—*Hippocastanata*, Hüb.‡	Hübn. Geom. tab. 36. f. 186. (mas.)

Genus 100. CABERA, *Ochs., Treitsch.*

(Cabera, Ephyra, Duponchel.
Cabera, Cyclophora, Stephens.)

All the *wings* pulverulent, or spotted with multitudes of minute dots, and traversed by from two to four bands.—*Palpi* scarcely projecting beyond the forehead.—*Maxillæ* long.

Species.	Icon.
1. Cab. *Pusaria*, Linn.§	Hübn. Geom. tab. 17. f. 87. (fœm.)
2.—*Exanthemaria*, Esper.§	Hübn. Geom. tab. 17. f. 88. (mas. tab. 98. f. 506. (fœm.)
3.—*Strigillaria*, Hübn.‖	Hübn. Geom. tab. 23. f. 125. (fœm.)
4.—*Onoraria*, Hübn.	Hübn. Geom. tab. 18. f. 93. (fœm.)
5.—*Punctaria*, Linn.¶	Esper. Schm. v. th. tab. vi. f. 5—7. tab. vii. f. 1. 2.
6.—*Poraria*, Treitsch.¶	Hübn. Geom. tab. 13. f. 67. (mas.)
7.—*Omicronaria*, Hübn.¶	Hübn. Geom. tab. 13. f. 65. (mas.)
8.—*Ocellaria*, Hübn.¶	Hübn. Geom. tab. 13. f. 64. (mas.)

* Chesias, Duponchel, Stephens.

† Lobophora, Stephens, Curtis.—"*Antennæ* rather short, setaceous.—*Maxillæ* not very long.—*Labial palpi* short, distant, incurved, thickly covered with scales.—*Wings* entire, extended horizontally when at rest; *upper* long, somewhat lanceolate; *lower* small in the males, with a lobe attached at the base of the abdominal margin.—*Head* small.—*Abdomen* and *legs* slender."—*Curtis. Brit. Ent. l. c. supra,* (Extract.)

‡ Pachycnemia, Stephens.

§ Cabera, Stephens.

‖ Cabera, Duponchel.

¶ Cyclophora, Stephens.

9. Cab.

Species. Icon.

9.Cab.*Pendularia*, Linn.* †Hübn. Geom. tab. 13. f. 66.(mas.)
10.—*Orbicularia*, Hübn.*...Hübn. Geom. tab. 12. f. 60.(mas.)
11.—*Pupillaria*, Hübn......Hübn. Geom. tab. 13. f. 69. (mas.)
12.—*Gyraria*, Hübn.........Hübn.Geom. tab.84. f.434.(mas.)
13.—*Trilinearia*, Bork.* ...Hübn. Geom. tab. 13. f.68.(fœm.)*

Genus 101. ACIDALIA, *Ochs.*, *Treitsch.*

(ACIDALIA, AMATHIA, LARENTIA, Duponchel. HEMEROPHILA, YPSIPETES, PHIBALAPTERYX, SCOTOSIA, TRIPHOSA, CHEIMATOBIA, LOBOPHORA, EMMELESIA, PTYCHOPODA, Stephens.)

All the *wings* marked with numerous undulated, transverse parallel lines.—*Larva* short, stout; generally of a green colour, with pale, longitudinal lines, or reddish streaks: segments of the body, distinct.—*Metamorphosis* subterraneau.

Species. Icon.

1.Acid.*Ochrearia*, Hübn...Hübn.Geom. tab.20. f. 110.(mas.)
2.—*Rufaria*, Hübn.........Hübn.Geom.tab. 21. f.112.(mas.)
3.—*Rubricaria*, Hübn.. ...Hübn.Geom. tab.21. f.111.(fœm.)
tab. 94. f. 487. (mas.)
4.—*Pygmæaria*, Hübn.....Hübn.Geom. tab.65.f.335. (mas.)
f. 336. (fœm.)
5.—*Vittaria*, Hübn.........Hübn.Geom. tab. 83. f.429.(mas.)
6.—*Pusillaria*, Hübn......Hübn.Geom. tab. 19. f. 99. (fœm.)
7.—*Decolorata*, Hübn.‡ ...Hübn.Geom. tab.47. f.243.(fœm.)
8.—*Albulata*, Hübn. ....Hübn.Geom. tab.50.f.257.(fœm.)
9.—*Sylvata*, Hübn..........Hübn.Geom. tab.44.f.231.(fœm.)
10.—*Luteata*, Fab.............Hübn.Geom. tab.19. f.103.(fœm.)
11.—*Alpestrata*, Hübn......Hübn.Geom.tab.62. f.320.(fœm.)
12.—*Scabraria*, Hübn.......Hübn.Geom. tab.44. f. 229. (mas.)
13.—*Elutata*, Hübn.§........Hübn.Geom. tab. 43. f.224.(mas.)
tab. 74. f. 385. (fœm.)
14.—*Impluviata*, Hübn.§ ...Hübn.Geom. tab. 43. f.223.(mas.)
15.—*Brumata*, Linn. ‖.......Hübn.Geom. tab.37. f. 191.(mas.)
tab. 99. f. 509. (fœm.)
16.—*Dilutata*, Hübn.. ......Hübn.Geom. tab. 36. f.188.(mas.)
17.—*Lobulata*, Hübn. ....Hübn.Geom. tab. 70. f.362.(mas.)

* CYCLOPHORA, Stephens.

† EPHYRA, Duponchel.—"Base of all the *wings* pulverulent, with a transverse line, and an omicron, more or less accurately defined, on the centre of the disc, in most of the species.—*Palpi* slender, very much inclined, and not projecting beyond the forehead.—*Maxillæ* long."—*Duponch, Lep. de France, tom.* vii. *part.* ii. p. 108.

‡ EMMELESIA, Stephens.

§ YPSIPETES, Stephens.

‖ CHEIMATOBIA, Stephens.

18.Acid.

Species.	Icon.
18. Acid. *Rupestrata*, Fab. ...	Hübn. Geom. tab. 37. f. 192. (mas.)
19.—*Candidata*, Borkh......	Hübn. Geom. tab. 19. f. 101. (fœm.)
20.—*Osseata*, Fab.*..........	Hübn. Geom. tab. 19. f. 102. (fœm.)
21.—*Pallidaria*, Hübn......	Hübn. Geom. tab. 18. f. 96. (mas.)
* 22.—*Strigaria*, Hübn.†......	Hübn. Geom. tab. 18. f. 98. (mas.)
23.—*Byssinata*, Treitsch.‡	
24.—*Sericeata*, Hübn........	Hübn. Geom. tab. 78. f. 404. (mas.)
25.—*Hexapterata*, Fab.§....	Hübn. Geom. tab. 44. f. 232. (mas.)
26.—*Sexalata*, Bork.‖	Hübn. Geom. tab. 44. f. 228. (mas.)
27.—*Rivulata*, Hübn.	Hübn. Geom. tab. 50. f. 259. (mas.)
28.—*Blandiata*, Hubn.	Hübn. Geom. tab. 50. f. 258. (mas.)
29.—*Rusticata*, Fab.	Hübn. Geom. tab. 46. f. 241. (mas.)
30.—*Filicata*, Hübn.	Hübn. Geom. tab. 46. f. 238. (fœm.)
31.—*Salicaria*, Treitsch....	Hübn. Geom. tab. 53. f. 273. (mas.)
32.—*Scripturata*, Hübn....	Hübn. Geom. tab. 53. f. 274. (mas.)
33.—*Coraciata*, Hübn.	Hübn. Geom. tab. 54. f. 278. (fœm.)
34.—*Frustata*, Treitsch.¶	
35.—*Viretata*, Hübn.	Hübn. Geom. tab. 44. f. 230. (mas.)
36.—*Riguata*, Hübn.	Hübn. Geom. tab. 69. f. 358. (fœm.)
37.—*Undulata*, Hübn......	Hübn. Geom. tab. 51. f. 262. (fœm.) tab. 85. f. 436. (mas.)
38.—*Vetulata*, Hübn.**....	Hübn. Geom. tab. 51. f. 263. (mas.)
39.—*Fluviata*, Hübn.	Hübn. Geom. tab. 54. f. 280. (fœm.) f. 281. (mas.)
40.—*Bilineata*, Linn......	Hübn. Geom. tab. 51. f. 264. (fœm.)
41.—*Bistrigata*, Treitsch.††	
42.—*Polygrammata*, Hubn.	Hübn. Geom. tab. 54. f. 277. (mas.)
43.—*Lignata*, Hübn......	Hübn. Geom. tab. 52. f. 270. (fœm.)
44.—*Tersata*, Hübn.‡‡....	Hübn. Geom. tab. 52. f. 268. (mas.) tab. 87. f. 448. (fœm.)

* Ptychopoda, Stephens.

† Acidalia, Duponchel.—"All the wings traversed by parallel lines, sometimes straight, sometimes wavy or sinuated, and varying from three to five, on an uniform ground colour. A point in the middle of each wing, on most species.—*Palpi* very short.—*Maxillæ* long.—*Antennæ* ciliated in the males."—*Duponch. Lep. de France, tom.* vii. *part.* ii. p. 108.

‡ Acid. alis albo flavicantibus, strigis obscurioribus.—*Ochs. Treitsch.* vi. *part.* v. p. 36.

§ Lobophora, Stephens.

‖ Amathia, Duponchel.—"*Upper wings* only traversed by very numerous parallel, wavy lines, separated by bands.—*Palpi* very short.—*Maxillæ* long.—*Lower wings* of the males, in many species, with an appendage resembling a third pair of rudimentary wings, near their base, on the inner side."—*Duponch. l. c.* p. 112.

¶ Acid. alis anticis fusco virescentibus, fascia obsoleta alba, strigisque obscurioribus; posticis cinereis.—*Ochs. Treitsch. l. c.* p. 50.

** Scotosia, Stephens.

†† Acid. alis anticis albido ferrugineis, strigis dentatis fuscis; posticis flavido ferrugineis, linea dentata fusca in medio.—*Ochs. Treitsch.* vi. *part.* v. p. 59.

‡‡ Phibalapteryx, Stephens.

45. Acid

Species.	Icon.
45. Acid. *Aquata*, Hübn. . . .	Hübn. Geom. tab. 79. f. 410. (fœm.)
46.—*Petrificaria*, Hüb. .	*Hübn. Geom. tab. 52. f. 267. (mas.)
47.—*Vitalbata*, Hübn.	Hübn. Geom. tab. 52. f. 269. (mas.)
48.—*Rhamnata*, Fab.	Hübn. Geom. tab. 52. f. 271. (mas.) tab. 77. f. 400. (fœm.)
49.—*Dubitata*, Linn.†	Hübn. Geom. tab. 51. f. 265. (fœm.)
50.—*Certata*, Hübn.	Hübn. Geom. tab. 51. f. 266. (mas.)

Genus 102. LARENTIA, *Ochs., Treitsch.*

(Eubolia, Anaitis, Duponchel.
Larentia, Aplocera, Eupithecia, Stephens.
Eupithecia, Curtis.)

Anterior wings, like those of the preceding genus, with wavy, transverse lines, and frequently a dark transverse band near the centre of the disc.—*Larva* short, stout, rugose, usually of a greenish colour, with spots or stripes.—*Metamorphosis* subterranean.

Species.	Icon.
1. La. *Cervinaria*, Treitsch.‡	Hübn. Geom. tab. 62. f. 318. (fœm.)
2.—*Mensuraria*, Treitsch.§	Hübn. Geom. tab. 37. f. 193. (mas.)
3.—*Badiata*, Hübn.	Hübn. Geom. tab. 56. f. 291. (mas.)
4.—*Plagiata*, Linn.‖	Hübn. Geom. tab. 42. f. 220. (fœm.)
5.—*Cassiata*, Treitsch.¶	
6.—*Sororiata*, Hübn.	Hübn. Geom. tab. 68. f. 355. (mas.)
7.—*Bipunctaria*, Fab. . . .	Hübn. Geom. tab. 53. f. 276. (mas.)
8.—*Cæsiata*, Hübn.	Hübn. Geom. tab. 53. f. 275. (mas.)
9—*Sertata*, Hübn.	Hübn. Geom. tab. 95. f. 489. (mas.)
10.—*Flavicinctata*, Hübn....	Hübn. Geom. tab. 68. f. 354. (fœm.)
11.—*Molluginata*, Hübn. . .	Hübn. Geom. tab. 71. f. 371. (fœm.)
12.—*Psittacata*, Fab.	Hübn. Geom. tab. 43. f. 227. (mas.)
13.—*Cyanata*, Hübn..	Hübn. Geom. tab. 62. f. 319. (mas.)

* Hemerophila, Stephens.

† Triphosa, Stephens.—Larentia, Duponchel.—"All the *wings* traversed by a great number of parallel lines, wavy, angular, or indented, and more distinct on the *upper* than on the *lower*.—*Palpi* long, projecting beyond the forehead.—*Maxillæ* long."—*Duponch. Lep. de France, tom.* vii. *part.* ii. p. 111.

‡ Larentia, Stephens. § Eubolia, Duponchel.—"*Upper wings* with a central transverse band, composed of several parallel lines, more or less undulated.—*Palpi* long, and pointed.—*Maxillæ* long."—*Duponch. Lep. de Fran. tom.* vii. *part.* ii. p. 109.

‖ Aplocera, Stephens.—Anaitis, Duponchel. — "*Upper wings* only traversed by a great number of angular, parallel lines, divided into bands of three lines each.—*Forehead* very prominent, but the *palpi* nevertheless projecting beyond it.—*Maxillæ* short."—*Duponch. l. c.* p. 111.

¶ Lar. alis anticis griseo glaucescentibus, fasciis duabus interruptis fusco ferrugineis; posticis griseo albidis.—*Ochs. Treitsch.* vi. *part.* ii. p. 85.

14. La.

Species.	Icon.
14. La. *Rectangulata*, Linn.*	Hübn. Geom. tab. 45. f. 255. fœm.) tab. 72. f. 372. (mas.)
15.—*Isogrammata*, Treitsch.†	
16.—*Cydoniata*, Borkh. . . .	Rösel, Ins. i. th. 3. cl. tab. viii. f. 1—3.
17.—*Inturbata*, Hübn.	Hübn. Geom. tab. 90. f. 461. (fœm.)
18.—*Valerianata*, Hübn. . .	Hübn. Geom. tab. 76. f. 395. (mas.)
19.—*Residuata*, Hübn. . . .	Hübn. Geom. tab. 91. f. 467. (fœm.)
20.—*Minutata*, Hübn.	Hübn. Geom. tab. 88. f. 454. (fœm.)
21.—*Austerata*, Hübn.	Hübn. Geom. tab. 89. f. 457. (mas.)
22.—*Satyrata*, Hübn.	Hübn. Geom. tab. 85. f. 439. (mas.)
23.—*Subnotata*, Hübn.	Hübn. Geom. tab. 89. f. 458. (fœm.)
24.—*Strobilata*, Hübn.	Hübn. Geom. tab. 87. f. 449. (mas.) 450. (fœm.)
25.—*Sobrinata*, Hübn.	Hübn. Geom. tab. 90. f. 465. (mas.)
26.—*Subumbrata*, Hübn. . . .	Hübn. Geom. tab. 45. f. 233. (fœm.)
27.—*Oxydata*, Treitsch.‡	
28.—*Pimpinellata*, Hübn. .	Hübn. Geom. tab. 86. f. 443. (mas.) 444. (fœm.)
29.—*Exiguata*, Hübn.	Hübn. Geom. tab. 73. f. 379. (fœm.)
30.—*Consignata*, Hübn. . . .	Hübn. Geom. tab. 47. f. 245. (fœm.)
31.—*Pusillata*, Fab.	Hübn. Geom. tab. 73. f. 378. (fœm.)
32.—*Hospitata*, Treitsch. . .	Hübn. Geom. tab. 45. f. 236. (mas.)
33.—*Linariata*, Fab. §	Hübn. Geom. tab. 46. f. 242. (mas.) Curtis. Brit. Ent. ii. pl. 64.
34.—*Irriguata*, Hübn.	Hübn. Geom. tab. 77. f. 397. (mas.)
35.—*Innotata*, Hübn.	Hübn. Geom. tab. 86. f. 441. (mas.) 442. (fœm.)
36.—*Centaureata*, Fab.	Hübn. Geom. tab. 46. f. 240. (mas.) tab. 88. f. 452. (fœm.)
37.—*Succenturiata*, Linn. . . .	Hübn. Geom. tab. 89. f. 459. (fœm.)
38.—*Denticulata*, Treitsch.‖	
39.—*Sparsata*, Hubn.	Hübn. Geom. tab. 77. f. 398. (fœm.)
40.—*Pygmæata*, Hubn.	Hübn. Geom. tab. 45. f. 234. (fœm.)
41.—*Nanata*, Hubn.	Hübn. Geom. tab. 75. f. 387. (mas.)

* EUPITHECIA, Stephens.

† Lar. alis cinereo fuscis, lineis undato albidis.—*Ochs. Treitsch. l. c.* p. 100.

‡ Lar. alis anticis fuscis, area ferruginea, puncto medio nigro, strigis obsoletis albidis; posticis cinereis, strigis interruptis albidis.—*Ochs. Treitsch. l. c.* p. 114.

§ EUPITHECIA, Curtis.—"*Antennæ* alike in both sexes, rather long, setaceous.—*Maxillæ* as long as the antennæ, slender.—*Palpi* projecting obliquely, like a beak, beyond the head, thickly covered with long and broad scales.—*Wings* entire, horizontal when at rest, superior long, somewhat lanceolate.—*Abdomen* short, slender.—*Legs* rather slender."—(Extract.) *Curtis l. c. supra.*

‖ Lar. alis albis, limbo strigisque obsoletis fuscescentibus, puncto medio nigro.—*Ochs. Treitsch.* vi. *part* ii. p. 132.

Species. Icon.

42.La. *Caliginata*, Treitsch.*

43.—*Venosata*, Fab. ....Hübn.Geom.tab.47. f. 244.(fœm.)

Genus 103. CIDARIA, *Ochs.*, *Treitsch.*

(CIDARIA, MELANIPPE, Duponchel.
CIDARIA, HARPALICÉ, ELECTRA, EMMELESIA, Stephens.)

Wings superior with a dark coloured, transverse band, across the centre of the disc, with its external margin angular.—*Larva* short, thick, each segment with angular spots, the angle pointing towards the head.—*Metamorphosis* in a slight web, amongst leaves on the ground, or beneath the surface.

Species. Icon.

1.Ci.*Propugnaria*, Treitsch.Hübn.Geom. tab.55. f.286.(fœm.)

2.—*Aptata*, Hübn. ....Hübn.Geom. tab.67. f.349.(fœm.)

3.—*Minorata*, Treitsch.†

4.—*Graphata*, Treitsch.‡

5.—*Quadrifasciaria*, Linn.§Hübn.Geom. tab.55. f.284.(fœm.)

6.—*Ferrugaria*, Wien.Verz.Hübn.Geom. tab.55.f.258.
tab. 89. f. 460. (fœm.) (mas.)

7.—*Ligustraria*, Hübn. ..Hübn.Geom. tab.55. f.282.(fœm)

8.—*Ocellata*, Linn.........Hübn.Geom. tab.48. f.252.(fœm.)

9.—*Galiata*, Hübn. ......Hübn.Geom. tab.53. f.272.(mas.)

10.—*Olivaria*, Treitsch. ...Hübn.Geom.tab.59. f.307.(fœm.)

11.—*Miaria*, Bork. ....Hübn.Geom. tab.57.f.292.(fœm.)

12.—*Tophaceata*, Hübn. ...Hübn.Geom. tab.60. f.309.(mas.)

13.—*Æquata*, Hübn. ......Hübn.Geom.tab.68. f.353.(mas.)

14.—*Nebulata*, Treitsch.‖

15.—*Populata*, Linn.¶ ......Hübn.Geom. tab.58. f.300. (mas.)

16.—*Chenopodiata*, Linn....Hübn.Geom. tab.58. f.299. (mas.)

17.—*Achatinata*, Hübn. ...Hübn.Geom. tab.58. f.301. (mas.)

18.—*Marmorata*, Hübn. ...Hübn.Geom. tab.54. f.279.(fœm.)

19.—*Mœniaria*, Fab. ......Hübn.Geom. tab.58. f.298.(fœm.)

20.—*Fulvata*, Hübn.[a] ......Hübn.Geom. tab.57. f.297. (mas.)

* Lar. alis plumbeis, atomis, strigisque fuscis.—*Ochs. Treitsch. l. c.* p. 137.

† Cid. alis albido griseis; anticis fasciis fuscis, albo marginatis, linea externa denticulata alba, puncto medio nigro.—*Ochs. Treitsch.* vi. *part.* ii. p. 143.

‡ Cid. alis cretaceis, atomis strigisque numerosis angulatis fuscis, puncto medio nigro.—*Ochs. Treitsch. l. c.* p. 144.

§ CIDARIA, Stephens.

‖ Cid. alis cinereo albidis, atomis nigris, fascia media obsoleta.—*Ochs. Treitsch. l. c.* p. 164.

¶ ELECTRA, Stephens.

[a] CIDARIA, Duponchel.—" *Upper Wings* traversed across the middle of the disc by a more or less wide band, always bent into one or more salient angles on the outer side.—*Palpi* projecting beyond the forehead.—*Maxillæ* long."—*Duponch. Lep. de France*, vii. *part.* ii. p. 111.

21. Ci.

Species.		Icon.
21.Ci.*Pyropata*, Hübn.	.....	Hübn.Geom. tab.63. f.328.(fœm.)
22.—*Sagittata*, Fab.	......	Hübn.Geom. tab.60. f.310.(fœm.)
23.—*Pyraliata*, Fab.	......	Hübn.Geom. tab.58. f.302. (mas.)
24.—*Derivata*, Hübn.	....	Hubn.Geom. tab.56. f.289.(fœm.)
25.—*Berberata*, Fab.	.....	Hübn.Geom. tab.56. f.287. (mas.)
26.—*Rubidata*, Fab.	......	Hübn.Geom. tab.56. f.290. (mas.)
27.—*Russata*, Hübn.	......	Hübn.Geom. tab.59. f.305.(fœm.)
28.—*Suffumata*, Hübn.	....	Hübn.Geom. tab.59. f.306. (mas.)
29.—*Picata*, Hübn.	......	Hübn.Geom. tab.84. f.435.(fœm.)
30.—*Prunata*, Linn.	......	Hübn.Geom. tab.59. f.304. (mas.)
31.—*Silaceata*, Hübn.	....	Hübn.Geom. tab. 59. f.303.(mas.) tab. 93. f.477. 478. (fœm.)
32.—*Reticulata*, Fab.	....	Hübn.Geom. tab.60. f.308.(fœm.)
33.—*Ruptata*, Hübn.	....	Hübn.Geom. tab.57. f.295.(fœm.)
34.—*Montanaria*, Treitsch.		Hübn.Geom. tab.48. f.248.(fœm.)
35.—*Alchemillata*, Linn.*	..	Hübn.Geom.tab.50. f.261.(fœm.)
36.—*Hastata*, Linn.†	....	Hübn.Geom.tab.49. f.256.(fœm.)
37.—*Tristata*, Linn.	......	Hübn.Geom. tab.49. f.254.(mas.) tab. 50. f. 260. (fœm.)
38.—*Rivata*, Hübn.	......	Hübn.Geom. tab.79. f.409.(fœm.)
39.—*Luctuata*, Hübn.	....	Hübn.Geom. tab.49. f.253.(mas.)
40.—*Turbaria*, Hübn.	....	Hübn.Geom. tab.49. f.255.(fœm.)

Genus 104. ZERENE, *Ochs.*, *Treitsch.*

(Melanthia, Venilia, Zerene, Corycia, Duponchel. Xerene, Cidaria, Hercyna, Abraxas, Bapta, Stephens.)

Wings superior, with the ground colour nearly white, or yellow, and a more or less interrupted, dark, transverse band. —*Larva*, thick in proportion to their length; back and sides marked with dots and lines; motion sluggish.—*Metamorphosis* in a slight web amongst leaves, or subterranean.

Species.		Icon.
1.Zer.*Procellata*, Fab.‡§	..	Hübn.Geom. tab.48.f.251.(fœm.)
2.—*Fluctuata*, Linn.‖	....	Hübn.Geom. tab.48. f.249.(mas.)
3.—*Stragulata*, Hübn.	..	Hübn.Geom. tab.65. f.337.(fœm.)
4.—*Rubiginata*, Fab.	....	Hübn.Geom. tab.48.f.250.(fœm.)

* Emmelesia, Stephens.

† Melanippe, Duponchel.—" All the *wings* terminated by a more or less interrupted band. Last joint of the *palpi* very pointed, scarcely projecting beyond the forehead.—*Maxillæ* long."—*Duponch. Lep. de France*, vii. *part.* ii. p. 111.

‡ Xerene, Stephens.

§ Melanthia, Duponchel.—" Head, thorax, and base of the upper wings of a deeper colour than the rest.—*Palpi* very short.—*Maxillæ* long."—*Duponch. Lep. de France*, vii. *part.* ii. p. 111.

‖ Cidaria, Stephens.

5. Zer.

Species.	Icon.
5. Zer. *Adustata*, Fab.	Hübn. Geom. tab. 15. f. 75. (mas.)
6.—*Suniata*, Hübn.......	Hübn. Geom. tab. 56. f. 288. (mas.)
7.—*Albicillata*, Linn.	Hübn. Geom. tab. 15. f. 76. (fœm.)
8.—*Marginata*, Linn.	Hübn. Geom. tab. 15. f. 80. (mas.)
9.—*Maculata*, Fab.*†	Hübn. Geom. tab. 25. f. 155. (mas.)
10.—*Melanaria*, Linn.	Hübn. Geom. tab. 16. f. 86. (mas.)
11.—*Grossulariata*, Linn.‡§	Hübn. Geom. tab. 16. f. 81. (fœm.)
12.—*Ulmaria*, Treitsch.. ..	Hübn. Geom. tab. 16. f. 85. (fœm.) tab. 76. f. 391. (mas.) f. 392. (fœm.)
13.—*Pantaria*, Linn.	Hübn. Geom. tab. 16. f. 84. (fœm.)
14.—*Cribrata*, Treitsch. ..	Hübn. Geom. tab. 16. f. 83. (mas.)
15.—*Taminata*, Wien. Verz.‖	Hübn. Geom. tab. 17. f. 90. (fœm.)
16.—*Temerata*, Wien. Verz.‖¶	Hübn. Geom. tab. 17. f. 91. (mas.) tab. 73. f. 376. (mas.) f. 377. (fœm.)

Genus 105. MINOA, *Ochs.*, *Treitsch.*

(Minoa, Cleogene, Tanagra, Duponchel. Minoa, Stephens.)

Wings, both on the upper and under surfaces, of one colour.—*Larva* with the body tapering anteriorly, naked, and generally of lively colours; head small.—*Metamorphosis* in a slight web. Divided into two families.

Fam. A.—With rounded wings.

Fam. B.—With the anterior wings lanceolate, with faint traces, occasionally, of one or two transverse bands.

Fam. A. Species.	Icon.
1. Min. *Euphorbiata*, Fab.[a]	Hübn. Geom. tab. 15. f. 78. (mas.)

* Hercyna, Stephens.

† Venilia, Duponchel.—"All the *wings* sprinkled with little irregular spots, both on the upper and under sides, on a light ground-colour.—*Palpi* long and velvety.—*Maxillæ* long."—*Duponch. l. c.* p. 110.

‡ Abraxas, Stephens.

§ Zerene, Duponchel.—"All the *wings* traversed across the middle by two rows of crowded spots, many of which form larger spots by their union.—*Abdomen* punctuated.—*Palpi* very short.—*Maxillæ* long, convolute only at the extremity."—*Duponch. l. c.* p. 110.

‖ Bapta, Stephens.

¶ Corcyria, Duponchel.—"Independent of the rest of the markings, which vary with the species, each *wing* has a distinct spot in or near the centre of its disc.—*Palpi* very short.—*Maxillæ* very long."—*Duponch. l. c.* p. 110.

[a] Minoa, Duponchel.—"All the *wings* of one colour, both on the upper and under sides; the *second wings* very much rounded.—*Palpi* short.—*Maxillæ* long."—*Duponch. l. c.* p. 112.

2. Min.

Species.	Icon.
2. Min. *Lutearia*, Fab.*....	Hübn. Geom. tab. 23. f. 121. (mas.)
3.—*Chærophyllata*, Linn.†‡	Hübn. Geom. tab. 38. f. 196. (mas.)
FAM. B.	
4.—*Griscata*, Wien. Verz...	Hübn. Geom. tab. 41. f. 216. (mas.)
5.—*Niveata*, Treitsch. ...	Hübn. Geom. tab. 41. f. 217. (fœm.)
6.—*Illibaria*, Hübn.	Hübn. Geom. tab. 40. f. 207. (mas.)

Genus 106. IDÆA, *Ochs.*, *Treitsch.*

(SIONA, PELLONIA, DOSITHEA, Duponchel.
IDÆA, PTYCHOPODA, Stephens.)

Obs. M. Duponchel, whose profound knowledge of the subject entitles his remarks to more than common attention and respect, says of this genus;—"prejudiced in favour of his (Treitschke's) arrangement of the Phalænidæ, I had intended to adopt it, unaltered, in this work; but on applying it to my own collection, I found that the Author comprehends a host of species, in his genera, which do not possess the characters assigned respectively to them; and that his nineteenth and last genus, which he calls *Idæa*, is composed of species the most incongruous, such as *dealbata*, *calabraria*, *ornataria*, &c.: so that one might imagine that he has here brought together all those species for which he could not find a place in either of his preceding eighteen genera, without troubling himself to consider whether or not any analogy exists between them. However, with the exception of this genus, which ought to be abolished, the others appear to rest on solid bases; and I have consequently adopted them, but with the restriction, of referring to each, those species only which really belong to it."—As to the name *Idæa*, Duponchel very justly observes that it cannot stand, having already been employed to denote an exotic genus of the Papilionidæ.

All the *wings* with two or three dusky, somewhat arched, and undulated transverse bands, with, generally, between them a point or crescent-shaped spot.—*Larva* very thin in proportion to their length, almost filiform.—*Metamorphosis* subterranean.

* CLEOGENE, Duponchel.—"All the *wings* of one colour, sometimes very light, sometimes very dark.—*Palpi* short, velvety.—*Maxillæ* very long."—*Duponch. l. c.* p. 109.

† MINOA, Stephens.

‡ TANAGRA, Duponchel. "Superior angle of the *first wings*, rounded.—*Body* long and thin.—*Palpi* short.—*Maxillæ* long."—*Duponch. l. c.* p. 112.

1. Id.

Species.	Icon.
1. Id. *Dealbata*, Linn.*	...Hübn. Geom. tab. 41. f. 214. (fœm.)
2.—*Decussata*, Wien. Verz.	.Hübn. Geom. tab. 41. f. 213. (mas.) f. 215. (fœm.)
3.—*Calabraria*, Hübn.	...Hübn. Geom. tab. 10. f. 49. (fœm.)
4.—*Vibicaria*, Linn.†	......Hübn. Geom. tab. 10. f. 50. (mas.)
5.—*Vincularia*, Hübn.	...Hübn. Geom. tab. 78. f. 402. (mas.)
6.—*Aureolaria*, Fab.	....Hübn. Geom. tab. 12. f. 62. (mas.)
7.—*Degenerata*, Treitsch.	Hübn. Geom. tab. 11. f. 57. (mas.)
8.—*Aversata*, Linn.	.....Hübn. Geom. tab. 11. f. 56. (mas.) tab. 75. f. 389. (fœm.)
9.—*Suffusata*, Treitsch.‡	
10.—*Remutata*, Linn.	....Hübn. Geom. tab. 18. f. 98. (fœm.)
11.—*Mutata*, Treitsch.	....Rösel, I. th. 3. cl. tab. 11. f. 1—3.
12.—*Submutata*, Treitsch.§	
13.—*Immutata*, Linn.	....Hübn. Geom. tab. 20. f. 108. (mas.)
14.—*Incanata*, Linn.	.....Hübn. Geom. tab 19. f. 100. (mas.) tab. 20. f. 106. (fœm.)
15.—*Ornata*, Fab.‖	......Hübn. Geom. tab. 14. f. 70. (mas.)
16.—*Decorata*, Wien. Verz.¶	Hübn. Geom. tab. 14. f. 71. (mas.)
17.—*Reversata*, Treitsch.[a]	
18.—*Biselata*, Borkh.	....Hübn. Geom. tab. 14. f. 73. (fœm.)
19.—*Scutulata*, Borkh.	....Hübn. Geom. tab. 14. f. 72. (fœm.)
20.—*Moniliata*, Fab.	.....Hübn. Geom. tab. 12. f. 59. (fœm.)
21.—*Lævigata*, Fab.	.....Hübn. Geom. tab. 14. f. 74. (fœm.)

At length we have completed our extracts from the *Schmetterlinge Von Europa*, as far as we have yet received the work. When the third part of the sixth volume shall reach us, we propose to resume our labours, in continuation. Till when, we heartily bid our entomological readers farewell.

* Idæa, Stephens.—Scoria, Duponchel.—"Nervures of the *wings*, very strong.—*Abdomen* long, linear.—*Palpi* with the last joint very acute, projecting beyond the forehead.—*Maxillæ* very long."—*Duponch. Lep. de Fran. tom.* vii. *part.* 2. p. 112.

† Pellonia, Duponchel.—"All the *wings* traversed by a narrow band towards the centre of the disc,—the band often separating into two lines. —*Antennæ* and *legs* very long.—*Palpi* obtuse, not projecting beyond the forehead.—*Maxillæ* long."—*Duponch. l. c.* p. 109.

‡ Id. alis virescenti flavidis, lineis obsoletis fuscescentibus, puncto medio nigro.—*Ochs. Treitsch.* vi. *part.* 2. p. 272.

§ Id. alis albidis, atomis cærulescentibus; anticis maculis costæ lineisque obsoletis fuscis.—*Ochs. Treitsch. l. c.* p. 277.

‖ Dosithea, Duponchel.—"All the *wings* with a point in the centre, on an uniform ground, and traversed near the extremity by a sinuous line, usually accompanied by confluent spots.—*Palpi* very short.—*Maxillæ* long. —*Antennæ* in the males rather ciliated than pectinated."—*Duponch. l. c.* p. 108.

¶ Ptychopoda, Stephens.

[a] Id. alis pallide flavis, margine externo fusco, lineaque undata albida, puncto medio nigro.—*Ochs. Treitsch. l. c.* p. 286.

LIST OF NEW PATENTS.

To T. Morgan, Tipton, Stafford, manufacturer of tin plates, for a method of manufacturing or preparing iron plates, or black plates for tinning.—Dated the 9th of September.—6 months allowed to enrol specification.

To R. Torrens, Croydon, Surrey, Lieutenant-Colonel in the royal marines, for an apparatus for the purpose of communicating power and motion.—9th of September.—6 months.

To D. Laurence, Stroud, and J. C. Ashford, gun-makers, Kent, for their improvements in apparatus to be applied to fowling-pieces and other fire-arms, in place of locks.—15th of September.—6 months.

To G. Harris, Brompton-crescent, Middlesex, captain in the royal navy, for his improvements in the manufacture of ropes and cordage, canvass and other fabrics or articles from substances hitherto unused for that purpose.—15th of September.—6 months.

To J. Milne, Edinburgh, architect, for a machine or engine for dressing stones used in masonry, by the assistance of a steam-engine, a wind, a horse, or a water power, whereby a great quantity of manual labour will be saved.—15th of September.—6 months.

METEOROLOGICAL OBSERVATIONS FOR OCTOBER 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·50. Oct. 10. Wind W.—Min. 29·42 Oct. 7. Wind N.
Range of the mercury 1·08.
Mean barometrical pressure for the month .... 30·077
Spaces described by the rising and falling of the mercury........... 7·170
Greatest variation in 24 hours 0·770.—Number of changes 22.
Therm. Max. 65° Oct. 2. Wind E.—Min. 30° Oct. 31. Wind N.
Range 35°.—Mean temp. of exter. air 50°·77. For 31 days with ☉ in ♎ 50·48
Max. var. in 24 hours 21°·00—Mean temp. of spring-water at 8 A.M. 54·38

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere in the evening of the 16th ... 98°
Greatest dryness of the atmosphere in the afternoon of the 6th... 52
Range of the index 46
Mean at 2 P.M. 68°·7.—Mean at 8 A.M. 75°·8.—Mean at 8 P.M. 79·8
—— of three observations each day at 8, 2, and 8 o'clock .... 74·8
Evaporation for the month 1·55 inch.
Rain in the pluviameter near the ground 1·47 inch.
Prevailing winds, S.W. and N.W.

Summary of the Weather.

A clear sky, 4½; fine, with various modifications of clouds, 13½; an overcast sky without rain, 8½; rain, 4½.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
20	6	29	0	14	17	15

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
6	4	1	½	0	8	4	7½	31

General Observations.—The weather this month has been mostly fine, with occasional showers, which were often accompanied by heavy gales of wind. On the 3rd instant, the last flight of swallows departed for a warmer climate. In the evenings of the 6th and 15th lunar halos appeared, and were followed by rain and wind.

On the mornings of the 7th, 8th, and 9th, ice appeared on the ground the first time this autumn, and the days were unusually cold: the maximum temperatrue of the 8th did not exceed 48 degrees, and light showers of snow were seen at Horndean, and in other parts of Hampshire. The mean temperature of this day and night is about equal to the mean of Christmas-day and night for the last fourteen years!

On the 25th a fine coloured parhelion appeared on the northern side of the sun, with a faint solar halo. In the afternoon of the 30th two winds crossed each other from North and West, when the clouds between them showed an electrical appearance, and lightning emanated from them in the evening.

The mean temperature of the external air this month, is two and a quarter degrees less than the mean of October for many years past.

The atmospheric and meteoric phænomena that have come within our observations this month, are, one parhelion, one solar and two lunar halos, five meteors, and thirteen gales of wind, or days on which they have prevailed; namely, three from the North, one from the North-east, six from the South-west, one from the West, and two from the North-west.

REMARKS.

London.—October 1. Very fine. 2. Drizzly: slight fog at night. 3. Stormy and wet. 4. Fine: drizzly in the afternoon. 5. Stormy, with showers: fine. 6. Fine. 7. Stormy rain: large flakes of snow fell in the afternoon and covered the ground a considerable thickness: strong gale at night. 8. Cold and stormy: snow lying on the hills. 9. Fine. 10. Very fine. 11, 12. Cloudy. 13. Fine morning: cloudy. 14. Stormy, but fair: heavy gale at night. 15. Clear and cold. 16. Cloudy. 17, 18. Very fine. 19. Cloudy. 20. Fine: drizzly at night. 21. Stormy, but fair: rain at night. 22. Cloudy. 23—25. Very fine, with slight fogs in the morning, and at night. 26. Foggy: cloudy. 27. Dense fog: fine. 28. Stormy. 29. Very fine. 30. Cloudy: drizzly at night. 31. Fine.

Penzance.—October 1. Fair. 2. Fair: rain. 3—7. Showery. 8. Clear. 9. Misty. 10. Fair. 11, 12. Misty. 13. Fair: rain at night. 14. Showery. 15. Clear. 16, 17. Misty. 18—21. Rain. 22. Showery. 23, 24. Clear. 25. Misty rain. 26, 27. Clear. 28. Fair: showers. 29. Clear. 30. Fair: rain. 31. Fair.

Boston.—October 1. Fine. 2. Cloudy. 3 Rain: rain early A.M. 4. Fine. 5. Cloudy: rain early A.M. 6. Fine. 7. Cloudy: snow storm 11 P.M. 8. Stormy. 9. Fine. 10—13. Cloudy. 14. Cloudy: rain early A.M. 15. Fine. 16. Cloudy. 17, 18. Fine. 19. Cloudy. 20. Cloudy: rain at night. 21. Fine: rain at night. 22. Cloudy: rain P.M. 23, 24. Fine. 25. Cloudy. 26. Misty. 27. Misty: ice this morning. 28. Fine. 29. Cloudy. 30. Cloudy: rain at night. 31. Fine.

Meteoro-

Meteorological Observations made by Mr. BOOTH *at the Garden of the Horticultural Society at Chiswick, near London; by Mr.* GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1829.	Barometer. London. Max.	Barometer. London. Min.	Barometer. Penzance. Max.	Barometer. Penzance. Min.	Barometer. Gosport. Max.	Barometer. Gosport. Min.	Barometer. Boston $8\frac{1}{2}$ A.M.	Thermometer. London. Max.	Thermometer. London. Min.	Thermometer. Penzance. Max.	Thermometer. Penzance. Min.	Thermometer. Gosport. Max.	Thermometer. Gosport. Min.	Thermometer. Bost. $8\frac{1}{2}$ A.M.	Wind. Lond.	Wind. Penz.	Wind. Gosp.	Wind. Bost.	Evap. Gosp.	Rain. Lond.	Rain. Penz.	Rain. Gosp.	Rain. Bost.
Oct. 1	30·264	30·183	30·10	30·08	30·24	30·14	29·60	62	50	57	47	61	54	50	E.	E.	NE.	calm	...	...	...	...	...
2	30·041	29·920	29·80	29·80	30·00	29·97	29·58	60	49	62	47	65	56	54·5	E.	SE.	E.	E.	...	0·08	...	0·080	...
3	29·945	29·755	29·90	29·85	29·94	29·85	29·16	60	45	60	48	61	46	53·5	NW.	NW.	W.	NW.	0·20	·44	0·060	·380	0·55
4	29·970	29·893	30·05	30·02	30·08	30·03	29·35	63	54	58	52	61	54	52·5	SW.	NW.	NW.	W.	...	·11	·100	...	·18
☽ 5	29·653	29·586	29·85	29·80	29·72	29·72	29·09	61	40	57	53	60	45	53	NE.	NW.	NW.	W.	...	·07	·100	·015	·13
6	29·725	29·667	29·86	29·80	29·78	29·77	29·10	57	35	56	47	57	42	48	E.	NW.	NW.	NW.	·20	...	·205	...	...
7	29·635	29·580	29·70	29·65	29·61	29·42	29·10	45	33	56	48	55	36	41	NE.	NW.	N.	W.	...	·58	·130	·186	...
8	30·111	29·837	30·15	30·10	30·14	29·90	29·36	50	30	48	43	48	33	39·5	NE.	N.	NW.	NW.	...	...	...	...	·10
9	30·391	30·153	30·40	30·25	30·37	30·25	29·76	53	29	55	45	50	38	41	NW.	NW.	NW.	N.	·15	...	...	...	...
10	30·458	30·384	30·40	30·35	30·50	30·47	29·90	53	38	56	50	59	52	48	SW.	N.	W.	calm	...	...	...	...	...
11	30·355	30·135	30·35	30·30	30·37	30·27	29·73	60	30	56	50	59	53	54	W.	W.	SW.	W.	...	...	...	·005	...
○ 12	30·159	30·122	30·20	30·10	30·22	30·21	29·55	59	30	58	53	61	51	52	W.	W.	W.	NW.	·10	...	...	·010	...
13	30·060	29·708	30·05	30·03	30·12	29·81	29·38	58	52	58	52	58	55	54	W.	SW.	SW.	NW.	...	·07	...	·010	...
14	29·973	29·413	30·00	29·70	29·95	29·51	28·85	53	36	51	46	57	37	50	N.	NE.	N.	NW.	...	...	·300	·020	·09
15	30·289	30·212	30·25	30·20	30·30	30·28	29·75	52	31	50	41	48	39	40·5	NW.	SE.	NW.	NW.	·15	...	·205	...	...
16	30·112	29·848	30·05	30·05	30·15	29·96	29·46	57	41	57	45	55	50	43·5	S.	SW.	SW.	NE.	...	...	...	·050	...
17	30·161	30·067	30·04	30·03	30·20	30·11	29·53	65	48	58	50	61	53	52	SW.	SW.	W.	NW.	...	...	...	...	...
18	30·138	30·111	30·06	30·06	30·21	30·13	29·52	61	50	58	52	62	52	55	W.	SW.	SW.	W.	·10	...	·080	·020	...
☾ 19	30·095	30·007	30·04	30·00	30·14	30·10	29·51	64	54	59	53	63	55	54	W.	SW.	SW.	NW.	...	...	·262	...	...
20	29·892	29·803	29·80	29·78	29·93	29·86	29·20	61	46	58	53	60	48	57	SW.	SW.	SW.	S.	...	·05	·640	·060	...
21	29·817	29·647	29·60	29·60	29·87	29·72	29·68	59	47	58	48	58	47	49	S.	NW.	SW.	NW.	·10	·11	·400	·360	·18
22	29·891	29·669	29·90	29·80	29·93	29·74	29·05	55	35	54	45	56	38	50·5	NW.	N.	NW.	W.	...	...	·150	·650	·23
23	29·985	29·973	30·05	30·00	29·99	29·97	29·44	56	30	56	46	50	39	42·5	NW.	NW.	NE.	NW.	...	...	...	...	...
24	29·983	29·954	30·08	30·08	30·00	29·97	29·53	54	34	54	44	53	39	44	NE.	NE.	NE.	NW.	·15	...	...	...	...
25	30·311	30·176	30·22	30·20	30·31	30·18	29·66	58	36	52	46	55	46	44	N.	NE.	NW.	calm	...	...	·075	...	...
26	30·402	30·377	30·35	30·30	30·38	30·37	29·90	52	33	56	46	53	42	41	N.	NE.	NE.	calm	...	...	...	...	...
● 27	30·423	30·295	30·35	30·34	30·42	30·40	29·90	55	37	53	44	51	48	38·5	E.	NE.	N.	calm	·20	·03	...	...	...
28	30·388	30·269	30·33	30·33	30·41	30·29	29·78	51	36	55	44	52	36	45·5	NE.	NE.	N.	NW.	...	...	...	...	...
29	30·386	30·290	30·30	30·25	30·40	30·33	29·90	56	33	55	40	50	40	40	N.	NE.	N.	N.	...	...	·030	...	...
30	30·126	29·941	30·15	30·15	30·19	30·08	29·63	56	42	55	46	54	50	48	SW.	W.	W.	W.	...	·06	...	·160	...
31	30·163	29·962	30·06	30·05	30·14	29·92	29·45	49	29	54	48	51	30	43	NW.	N.	N.	N.	·20	...	·040	...	·10
Aver.	30·478	29·413	30·40	29·60	30·50	29·42	29·49	65	29	62	40	65	39	47·7					1·55	1·60	3·035	1·470	1·40

INDEX TO VOL. VI.

END OF THE SIXTH VOLUME.

LONDON:
PRINTED BY RICHARD TAYLOR,
PRINTER TO THE UNIVERSITY OF LONDON,
RED LION COURT, FLEET STREET.
1829.